MAY 1 1947

ENGINEERING NEWS-RECORD

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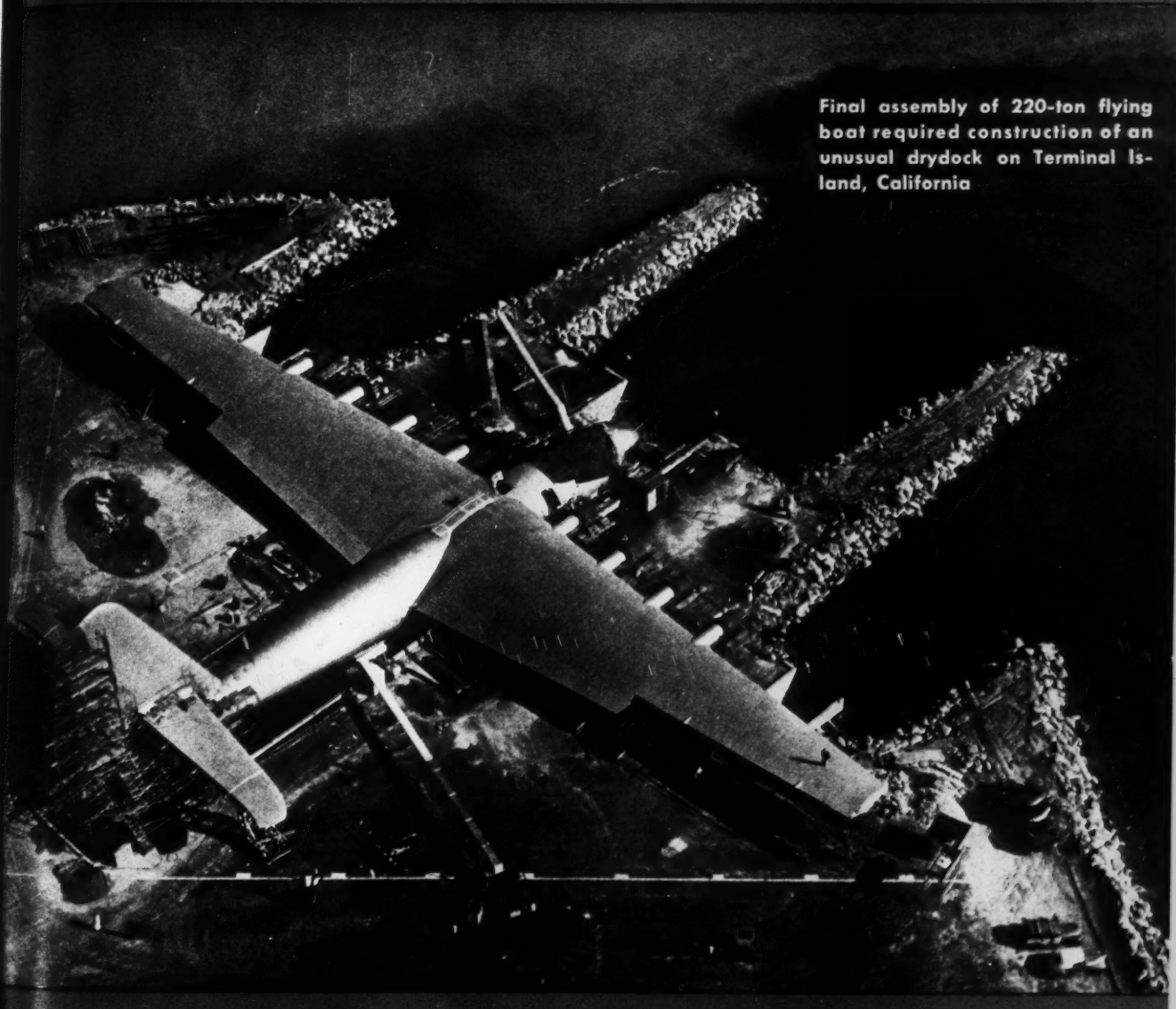
MAY 1, 1947



Final assembly of 220-ton flying boat required construction of an unusual drydock on Terminal Island, California

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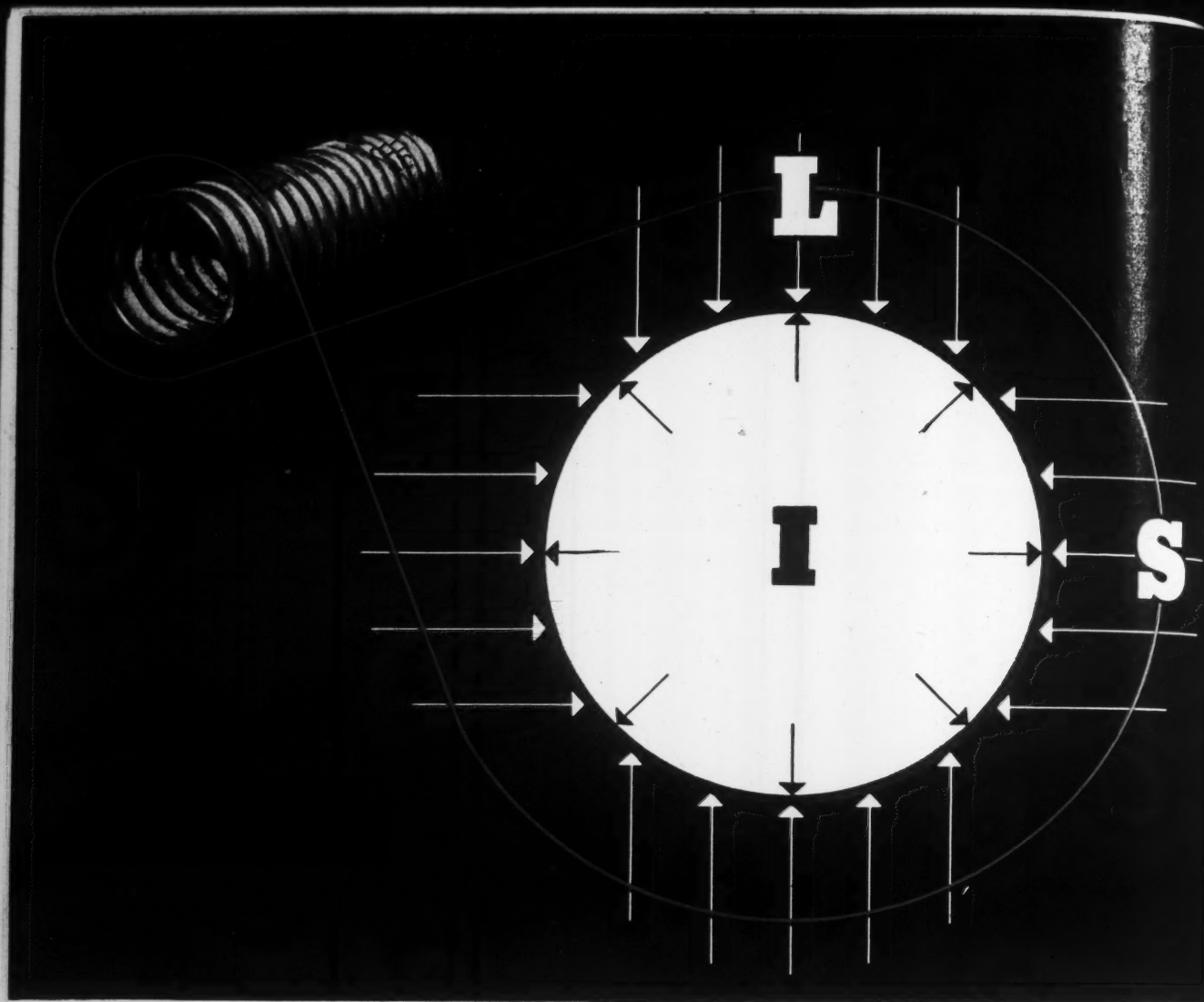
PUZZLE IN PANAMA.....

Fitting the Canal to an A-Bomb Age



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Volume 138 • Number 18

ENGINEERING NEWS-RECORD

May 1, 1947

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A 16-YEAR CONSOLIDATED INDEX

A consolidated index of Engineering News-Record covering the years 1928-1943 inclusive will be available late in April. This 414-page book includes all articles published during those years and all news items except those of ephemeral nature. Its price is $8. Copies can be obtained by sending this coupon with a check or money order to:

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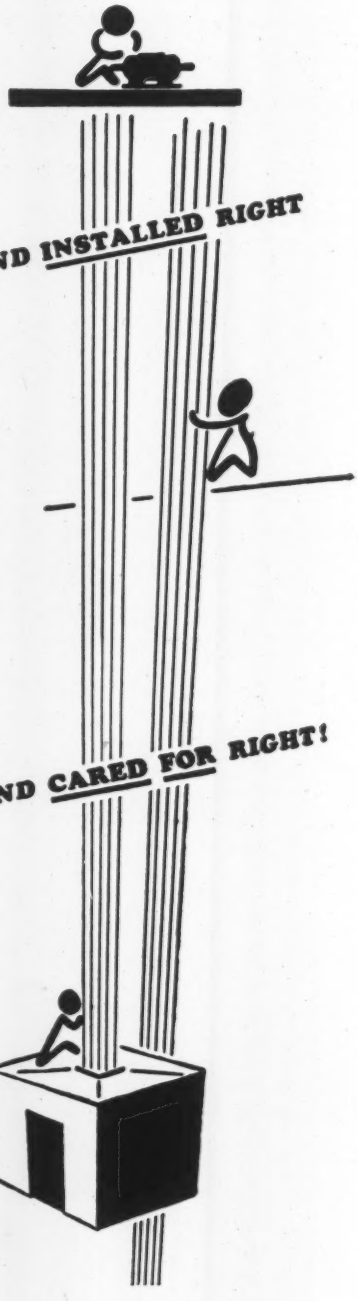

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Construction Trends

Construction Employment Gains Slowing Down

Construction employment, as estimated by the United States Bureau of Labor Statistics, increased to 1,605,000 persons in March, according to preliminary estimates, but this was only a 7.2 percent increase over March, 1946 compared with a 9.5 percent increase in February, 1947 over February, 1946 and a 33 percent increase in January, 1947 over January, 1946. Thus, as can be noted, construction employment follows the pattern already set in the reduced rate of increase in construction contract awards.

Of the total employment estimated for construction workers, 1,290,000, or 80 percent, were on private projects in March, 1947. This was a decline of 9.2 percent from March, 1946, when 1,420,000 private construction workers were employed.

Employment on public construction rose in March, 1947 to 315,000 and is approximately 20 percent of estimated total construction employment. Public construction employment shows a 59 percent gain over March, 1946, but it was at its war and postwar low a year ago and then represented only 5 percent of estimated total construction employment.

In 1946, for the first time since 1942, construction workers exceeded 2,000,000 on the job in any one month. The postwar construction employment peak to date was reached in September, 1946 with an estimated total of 2,313,000 workers. This represented uninterrupted gains each month from the low of 671,000 in January, 1945.

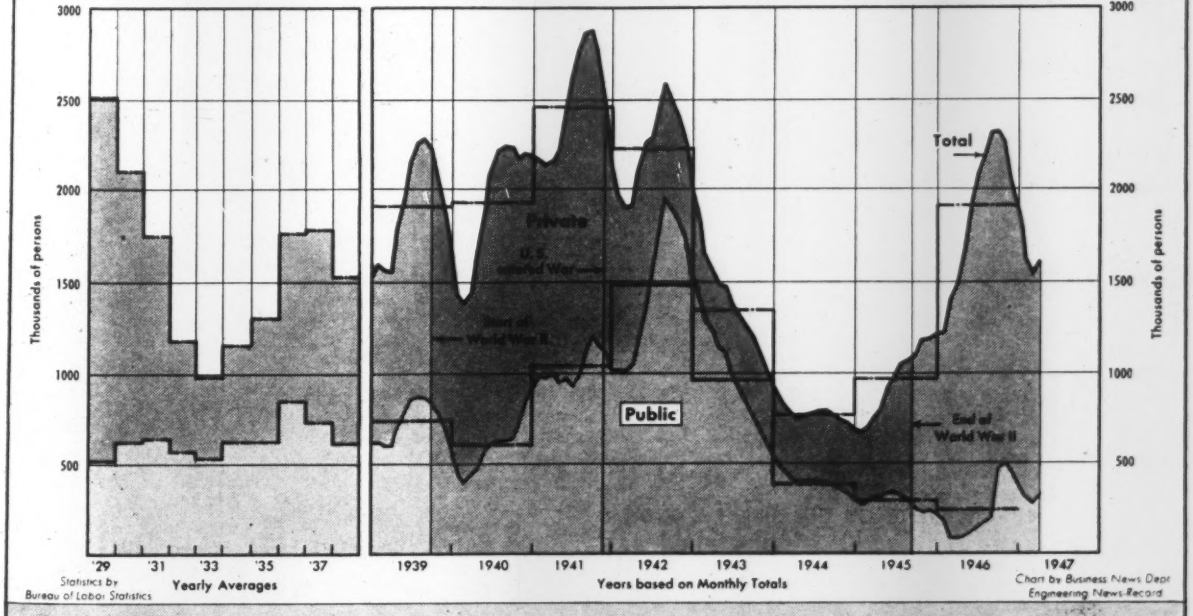
A year ago, construction employment increased 14 percent from January to February; this year it declined 5 percent. A year ago, it increased 6 percent from February to March; this year, 4 percent. The two-month gain a year ago was 22 percent; this year it is a decline of 1 percent.

This slowing up in construction employment gains is not due to a lack of needed construction. The backlog of proposed construction, for example, was $38,149,982,000 at the end of March, 1947 compared with $29,719,112,000 a year ago. It is further evidence that new work is currently being postponed while the cost trends are watched for better prices.

TOTAL CONSTRUCTION EMPLOYMENT
Bureau of Labor Statistics
(In Thousands)

	1939	1940	1941	1942	1943	1944	1945	1946	1947
January	1582	1420	2073	1960	1827	827	671	1223	1628
February	1564	1367	2047	1902	1653	779	708	1406	1539
March	1552	1418	2078	1912	1551	746	758	1497	1605
April	1813	1657	2216	2106	1482	759	809	1681	
May	1973	1872	2448	2251	1465	769	908	1927	
June	2144	2090	2615	2292	1365	779	970	2072	
July	2249	2210	2774	2453	1301	787	1043	2182	
August	2276	2228	2863	2579	1254	790	1065	2300	
September	2215	2220	2879	2469	1177	760	1097	2313	
October	2035	2146	2698	2400	1083	741	1175	2250	
November	1853	2186	2498	2262	996	720	1183	2057	
December	1650	2173	2160	1987	905	683	1215	1846	
Average	1909	1916	2446	2214	1338	762	967	1896	

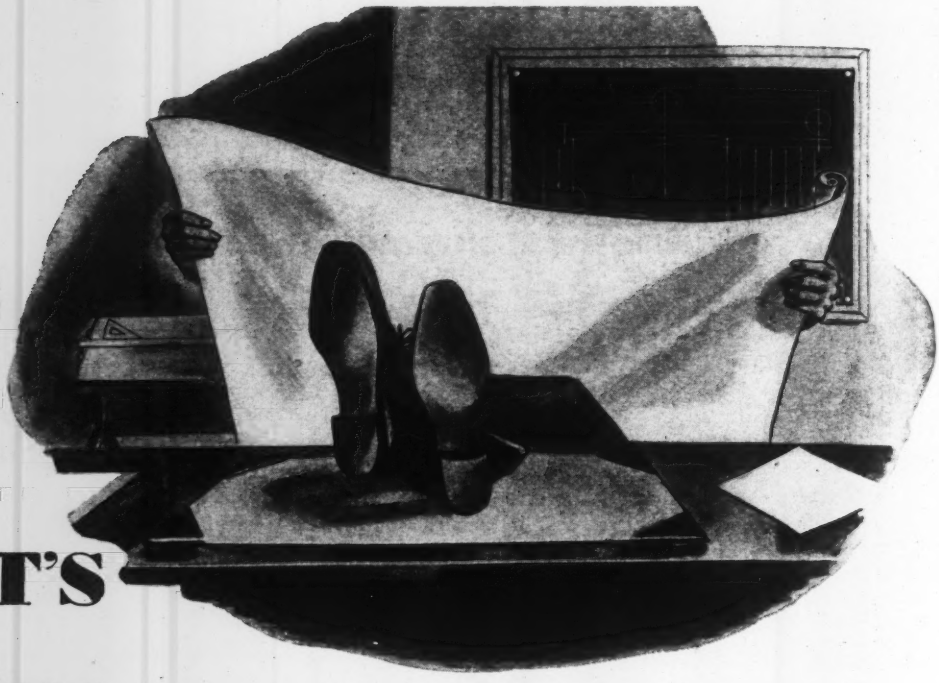
CONSTRUCTION EMPLOYMENT – PUBLIC AND PRIVATE – RECORD SINCE 1929



Statistics by Bureau of Labor Statistics

Chart by Business News Dept. Engineering News-Record

IF WE WERE IN YOUR CLIENT'S SHOES...



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LONG LIFE—to give us full value from our investment.

DEPENDABILITY—for positive, unfailing protection.

SIMPLICITY—so that the operator need not be a "gadgeteer" to keep it working.

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ADEQUATE SERVICE FACILITIES—to give us prompt, efficient service whenever needed for inspection or adjustment.

SOUND ENGINEERING—resulting in proved and workmanlike designs and installations.

A MANUFACTURER WITH EXPERIENCE—to back up his recommendations and insure a job-engineered installation to meet our particular needs.

AND THOSE ARE THE THINGS YOU'LL FIND IN EVERY W & T CHLORINATOR—from small Hypochlorinators for ounces of chlorine per day to Master Visible Vacuum Chlorinators of 6,000 pounds per day capacity.

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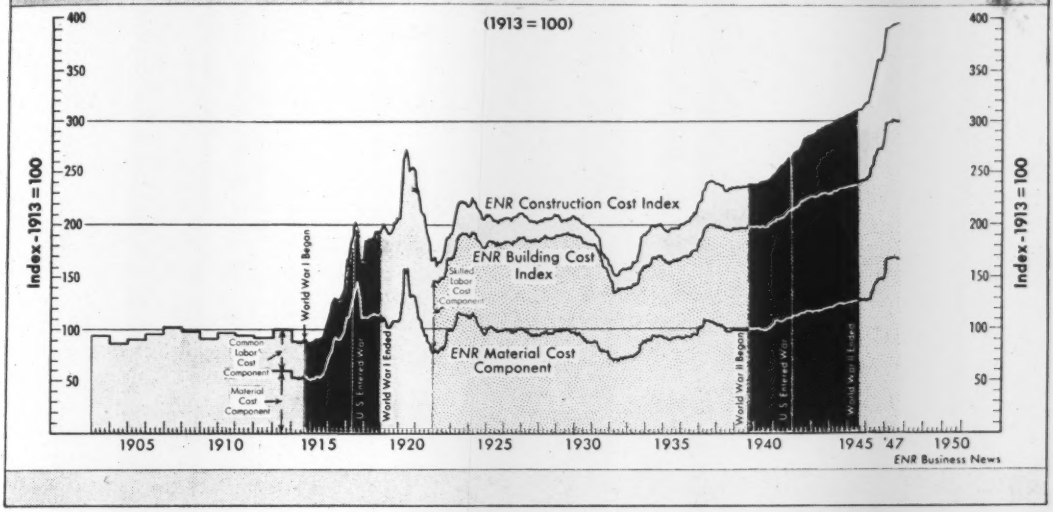
MAY CONSTRUCTION BUSINESS REPORT

ENGINEERING NEWS-RECORD CONSTRUCTION AND BUILDING COST INDEX TRENDS



ENR CONSTRUCTION VOLUME AND NEW PRODUCTIVE CAPITAL

Thousands of Dollars (,000 omitted)	April 1946 (4 wk.)	April 1947 (4 wk.)	% Change	Four Months 1946 (17 wk.)	Four Months 1947 (17 wk.)	% Change
Total U. S. Construction	$536,190	$454,471	−15	$1,516,473	$1,642,347	+8
Private Construction	348,560	213,667	−39	1,001,950	1,008,198	+0.6
Public Construction	187,630	240,804	+28	514,523	634,149	+23
Federal	63,355	65,983	+4	173,280	153,475	−11
E N R Construction Volume Index, 1913 = 100	345	247	−28	240	215	−10
Total New Productive Capital	82,741	282,140	+241	439,959	538,144	+22
Private Investment	82,741	282,140	+241	281,639	538,144	+91
Federal (non-federal work)	.....	.....	.....	.....	.....	.....
Federal (federal work)	.....	.....	.....	158,320	.....	.....

CONSTRUCTION COST . . . . WAGE RATES . . . . MATERIAL PRICES

1913 = 100	May 1946	May 1947	% Change	Change April to May 1946 April	1946 May	1946 %	1947 April	1947 May	1947 %
E N R Constr. Cost Index†	339.69	396.49	+16.72	334.59	389.69	+1.52	396.09	396.49	+0.10
E N R Building Cost Index†	257.25	299.61	+16.47	254.37	257.25	+1.11	300.81	299.61	−0.40

†*Does not reflect increased costs due to overtime, lower labor efficiency, delivery delays, etc.*

ENR 20-CITIES' AVERAGE

	May 1946	May 1947	% Change	Change April to May 1946 April	1946 May	1946 %	1947 April	1947 May	1947 %
Common Labor	$1.018	$1.146	+12.57	$1.004	$1.018	+1.01	$1.138	$1.146	+0.70
Skilled Labor (Av. 3 trades)	1.7718	1.935	+9.21	1.762	1.7718	+.57	1.935	1.935	0.0
Bricklayers	1.8817	2.078	+10.43	1.881	1.8817	+.06	2.078	2.078	0.0
Structural Ironworkers	1.7908	1.937	+8.16	1.786	1.7908	+.28	1.937	1.937	0.0
Carpenters	1.643	1.792	+9.07	1.620	1.643	+1.42	1.792	1.792	0.0
Reinforcing Steel, cwt	3.058	3.750	+22.63	3.015	3.058	+1.43	3.736	3.750	+0.37
Structural Steel, base	2.35	2.50	+6.38	2.35	2.35	0.0	2.50	2.50	0.0
Sand, per ton	1.377	1.740	+26.36	1.44	1.377	−4.37	1.737	1.740	+0.17
Common brick, per M	20.23	22.684	+12.13	26.20	20.23	−22.78	22.658	22.684	+0.11
Ready-mixed concrete, c.y.	7.88	8.853	+12.35	7.80	7.88	+1.03	8.867	8.853	−0 16
Struct. clay tile, 3x12x12	91.52	108.05	+18.06	97.38	91.52	−6.01	108.05	108.05	0.0

MATERIAL SHIPMENTS . . . . BUILDING PERMITS

	April 1946	April 1947	% Change	March 1947	% Change March to April
Steel (% operating Capacity) A.I.S.I.	84.4	95.0	+13	95.9	−1

	February 1946	February 1947	% Change	Two Months 1946	Two Months 1947	% Change
Cement, thous. bbl. U.S.B. of Mines	7,853	8,347	+6	15,244	16,711	+10

	March 1946	March 1947	% Change	Three Months 1946	Three Months 1947	% Change
Fabricated Structural Steel, tons, A.I.S.C.	86,872	134,011	+54	226,389	405,542	+79
Building Permits, 215 Cities, Dun & Bradstreet (,000 Omitted)	$425,237	$235,063	−45	$827,975	$558,694	−33

COST OF LIVING INDEX . . . . EMPLOYMENT

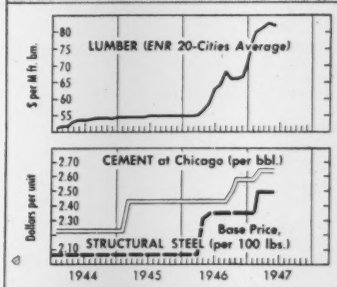
	February 1946	February 1947	% Change	January 1947	% Change January to February
Consumers' Price Index, B L S	129.6	152.8	+17.9	153.1	−0.2
Rent (Housing) Index, B L S	108.3	108.9	+0.6	108.8	+0.1

	March 1946	March 1947	% Change	February 1947	% Change February to March
Const. Employment (est.), thous., B L S	1,497	1,605	+7.2	1,539	+4.3
Private Const. Employ. (est.), thous., B L S	1,316	1,290	−2.0	1,628	−20.8

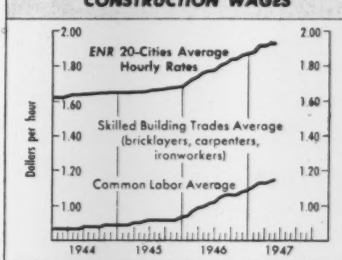
ENR INDEX NUMBERS

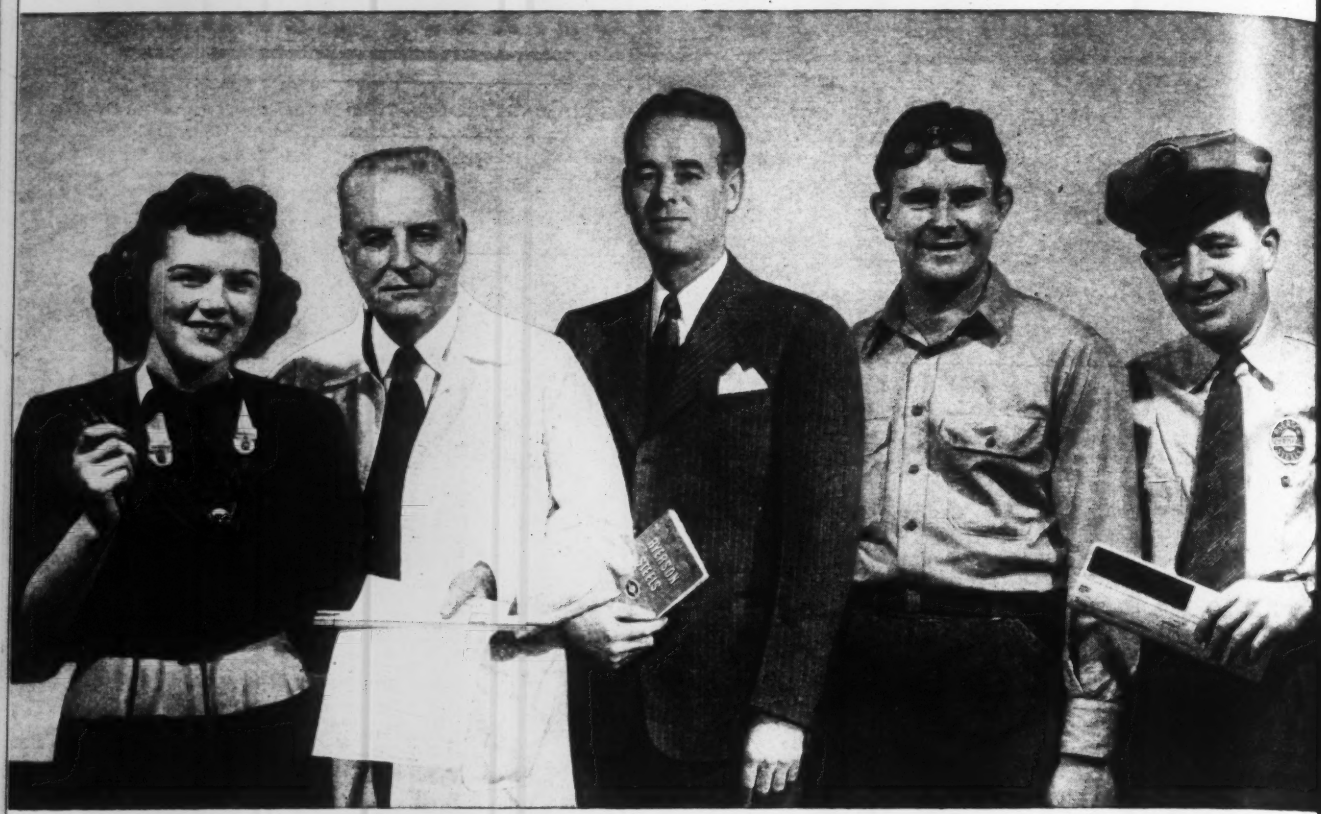
Base = 100	Construction Cost May, 1947	Construction Cost Apr., 1947	Construction Cost Mar., 1947	Building Cost 1913	Building Cost 1926	Volume '13	Volume '26
May, 1947	396.49	190.59	299.61	161.96	...	...	
Apr., 1947	396.09	190.40	300.81	162.61	247	108	
Mar., 1947	391.93	188.40	298.82	161.53	220	96	
Feb., 1947	390.76	187.84	297.38	160.75	197	86	
Jan., 1947	381.68	183.47	288.78	156.11	195	86	
Dec., 1946	368.10	176.95	278.49	150.54	207	91	
Nov., 1946	362.47	174.24	273.71	147.96	164	72	
Oct., 1946	360.94	173.50	272.74	147.43	233	102	
Sept. 1946	360.19	173.14	272.04	147.06	233	98	
Aug., 1946	361.37	173.71	271.98	147.02	258	113	
July, 1946	353.89	170.11	266.13	143.86	327	144	
June, 1946	347.91	167.24	264.16	142.80	344	151	
May, 1946	339.69	163.29	257.25	139.06	284	125	
1946 (Av.)	345.74	166.19	261.87	141.55	250	110	
1945 (Av.)	307.74	147.93	239.14	129.27	123	54	
1944 (Av.)	298.63	143.39	234.73	126.89	95	42	
1943 (Av.)	289.95	139.38	228.75	123.66	176	77	

MATERIAL COST PRICES



CONSTRUCTION WAGES





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New Construction Volume in April

Civil engineering construction volume in continental United States totals $454,471,000 for April, an average of $113,618,000 for each of the four weeks of the month. This average is 13 percent above the average for March, but 15 percent below the average for April, 1946, according to *Engineering News-Record*.

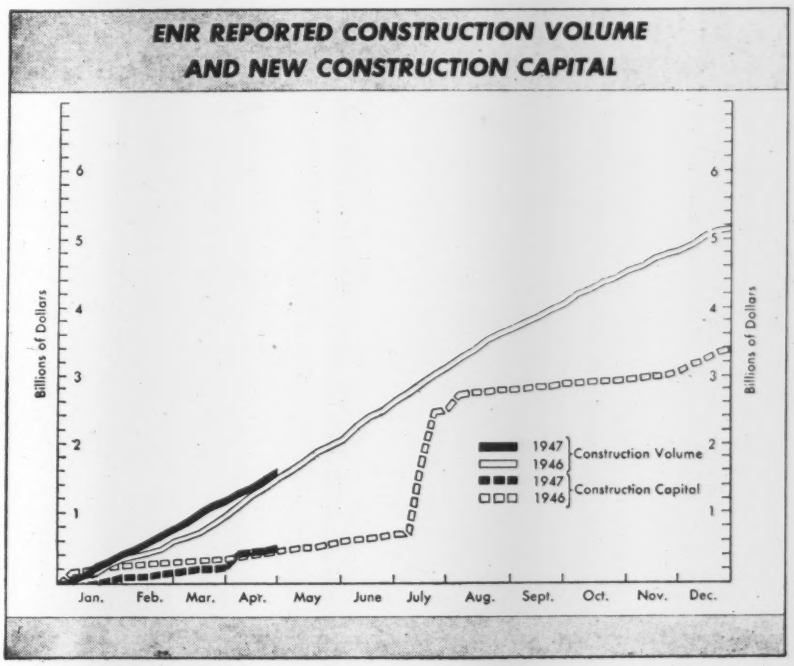
Private construction for April on a weekly average basis is 25 percent below last month and 39 percent below April, 1946. Public construction is 111 percent above last month and 28 percent above last April. State and municipal construction is 77 percent above last month, and 41 percent above the average for April, 1946. Federal construction, up 324 percent from last month, is 4 percent above April, 1946.

Weekly averages in the various classes of construction for April, 1947 compared with March, 1947, show gains in industrial buildings, of 31 percent; public bridges, 33 percent; public buildings, 58 percent; highways, 73 percent; waterworks, 95 percent; sewerage, 107 percent; public unclassified, 163 percent; and earthwork and drainage, 696 percent; losses in commercial buildings, 25 percent; private unclassified, 74 percent; and private bridges, 91 percent.

Put geographically, five sections showed gains in April, 1947 over March—Middle West, 1 percent; South, 4 percent; Middle Atlantic, 7 percent; Far West, 16 percent; and West of the Mississippi, 48 percent. New England dropped 16 percent from March to April.

One section showed a gain in April over April, 1946—South, 9 percent. West of the Mississippi dropped 0.04 percent below last year; Middle Atlantic, 17 percent; Middle West, 21 percent; Far West, 27 percent; and New England, 50 percent.

New capital for construction purposes for the four weeks of April, 1947 totals $282,140,000, or a weekly average of $70,535,000. The April average was thus 286 percent above the March, 1947 average, and 241 percent above the average for April, 1946.



ENGINEERING CONSTRUCTION CONTRACTS REPORTED TO ENGINEERING NEWS-RECORD — APRIL, 1947

Engineering News-Record *reports continental U. S. Construction projects of the following minimum costs — Waterworks, excavation, drainage and irrigation,* $22,500; *other public works,* $40,000; *industrial buildings,* $55,000; *other buildings,* $205,000.

Four Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States: April 1947	United States: Four Months 1947	United States: Four Months 1946	Canada
Public Works										
Waterworks	50	10,129	2,272	941	1,067	1,677	16,136	43,496	33,366	1,275
Sewerage	50	4,434	687	1,102	1,596	1,262	9,131	29,506	19,263	428
Bridges, public	1,032	947	5,154	3,155	3,543	2,215	16,046	50,706	34,254	240
Earthwork and waterways	875	4,903	12,669	1,605	17,681	16,903	54,636	83,409	97,528	365
Streets and roads	1,754	25,332	17,154	7,192	22,054	6,637	80,123	202,200	183,538	6,021
Buildings, public	2,684	10,404	9,127	6,918	11,265	7,212	47,610	159,557	98,588	5,656
Unclassified, public	11	4,878	616	370	1,762	9,485	17,122	65,275	47,986	2,616
Total public	6,456	61,027	47,679	21,283	58,968	45,391	240,804	634,149	514,523	16,601
Federal government (included in above classifications)	1,481	8,546	13,982	2,847	19,367	19,760	65,983	153,475	173,280	.....
Private										
Bridges, private	.....	.....	.....	40	.....	.....	40	463	1,206	.....
Industrial buildings	1,750	5,833	5,482	23,897	22,833	13,605	73,400	264,179	336,777	9,411
Commercial buildings	5,900	42,729	17,683	16,761	10,036	30,085	123,194	613,156	595,440	6,925
Unclassified, private	40	175	1,771	4,272	10,775	.....	17,033	130,400	68,527	75
Total private	7,690	48,737	24,936	44,970	43,644	43,690	213,667	1,008,198	1,001,950	16,411
Total Engineering Construction:										
April, 1947 — 4 weeks	14,146	109,764	72,615	66,253	102,612	89,081	454,471	.....	.....	33,012
March, 1947 — 4 weeks	16,844	102,346	69,584	65,329	69,522	76,790	400,415	.....	.....	29,996
April, 1946 — 4 weeks	28,471	132,145	66,904	83,490	102,657	122,523	536,190	.....	.....	27,230
Four months — 1947	63,034	437,297	280,537	217,520	330,849	313,110	.....	1,642,347	.....	139,278
Four months — 1946	105,242	339,560	175,044	203,214	311,383	382,030	.....	.....	1,516,473	98,544

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News of the Week

ENGINEERING NEWS-RECORD • MAY 1, 1947 • VOLUME 138 • NUMBER 18

ASCE told of harmful effect of Colorado River diversion

Papers at spring meeting at Phoenix, Ariz., concern problems of water quality, sedimentation, other matters caused by diversion — Board acts on dues

In order to protect their own existing and potential water supplies, California and Arizona should jointly oppose any further intermountain diversion of Colorado River water, members of the American Society of Civil Engineers were told last week.

The problem of preventing further damage to the quality of the water remaining in the river after such diversion and injury to irrigators and others because of increased scour and sedimentation were among many discussed by speakers at the society's spring meeting, held at Phoenix, Ariz., April 23-25.

At the same session, the organization's Board of Direction approved for submission to the membership a constitutional amendment calling for a $5 increase in dues for all corporate members; and considered revision of the constitution to make dues for all junior members a flat $12.50 per year.

Harmful effect of diversion

Urging opposition to further intermountain diversion of Colorado waters, G. E. Arnold, assistant city manager of San Diego, Calif., speaking to the sanitary engineering division, pointed out that already the best quality water—that with low mineral content—is being diverted. "The mineral content of the remaining water is increased. . . as well by the return of drainage and spent irrigation waters," he added.

"The water quality problem has been seriously overlooked," he continued. "Neither the Colorado River Compact nor the Mexican Water Treaty mention it. I predict that in the future we may see total solids content of 1,000 to 1,500 ppm. in the lower basin. This would require further expensive treatment facilities—and the Metropolitan Water District of Southern California already has the world's largest softening plant to treat water from the Colorado River."

Other aspects of Colorado River

Other aspects of the problem under discussion included the dependence of the Arizona-Southern California area on the river for its power requirements; the question of higher evaporation losses, and the economic effects of increased sedimentation on the river.

J. T. Kimball, assistant to the president of the Central Arizona Power and Light Co., told the power division that power to meet Arizona's currently critical shortage (caused by drought and growth of the area) will be supplied by steam plants in Southern California until about 1950, when it is estimated that Davis Dam power will be available. H. F. McPhail, of the power utilization branch of the Bureau of Reclamation, urged the construction of the 750,000 kw. Bridge Canyon Project and others to meet this need. Bridge Canyon's cost of $120 million a year for five years was cited by S. B. Morris, general manager, Los Angeles Department of Water and Power as a deterrent to quick approval by Congress, however.

Also in discussing Mr. McPhail's paper, R. A. Hill, Los Angeles consulting engineer, called attention to the enormous evaporation losses caused by construction of the Colorado River reservoirs. He said 10 percent of the river flow is now lost in this manner, and warned this loss may be doubled on full development of the river.

C. A. Carson, Phoenix attorney, calling attention to the "dire need" of central Arizona for additional water, said that 725,000 acres of land now under cultivation cause an overdraft of some 1,000,000 ac. ft. a year, and said that construction of the proposed Central Arizona Project (Bridge Canyon) is the only solution to the shortage.

W. E. Corfitzen, of the Washington, D. C. office of the Bureau of Reclamation, cited Laguna Dam on the Colorado as an example of the economic effect of sedimentation in reservoirs. This dam, built in 1909 at a cost of $1,921,000 raised the river water surface 10 ft. In less than a year, the reservoir thus formed was filled with sediment.

Construction of dams on the Colorado has aggravated the problem of retrogression or scour downstream, J. W.

(*Continued on page 55*)

***ASCE Leaders**—Preparing for the spring meeting of the American Society of Civil Engineers, E. M. Hastings (left) greets J. H. Gardiner, director of District 11; Walter Johanessen, president of the Arizona section, and William N. Carey, secretary of the organization.*

NEWS IN BRIEF

In telegraphic form, here are latest news developments on the engineering and construction front during the week.

Housing—Twenty-five contractors in *Rockford, Ill.*, plan to begin construction this year of 540 structures to provide 608 dwelling units. . . . Realty companies in *East St. Louis, Ill.*, plan a 225-home development there to cost over $2,000,000. . . . Bradford Homes, Inc., has plans to build 410 houses in *Indianapolis, Ind.*, at a total cost of over $4,000,000. It is hoped to complete 65 houses this year and 12 a week in 1948. . . . Joseph M. Kaminsky will begin construction soon on 250 homes in *Binghamton, N. Y.* . . . Permits for 39,999 new housing units were granted in Canada last year, plus 3,629 permits for conversions. This total of 43,628 compares with 28,569 in 1945. The aggregate value $382,028,707 is against the $198,187,000 of 1945.

Public Construction — The *Dade County, Fla.*, Board of Public Instruction in June will begin a $3,000,000 four-school construction program. . . . *Joplin, Mo.*, has approved plans to spend $460,000 on city airport improvements. . . . *Warren, Ohio*, will sell $2,750,000 in bonds for a 5-year school building program. . . . Construction of a new $1,700,000 Florida Supreme Court and State Library building and a $1,614,000 State College for Women music building has been assured by the allocation of additional funds.

Industrial Construction—The Southern Acid and Sulphur Co. will build a $1,000,000 plant at *North Little Rock, Ark.* . . . The application of the Chrysler Corp. to build a $3,000,000 parts depot near *Newark, Del.*, has been approved, by the Office of the Housing Expediter. The plant will consist of a warehouse with nearly 650,000 sq. ft. of floor space, plus a 2-story office building. The project, designed by Albert Kahn Associated Architects and Engineers, Inc., is expected to require a year to build. . . . The Chesapeake & Ohio Ry. Co. has been given permission to spend $369,000 to enlarge its freight terminal at *Russell, Ky.*

Highways—Low bidders on 16 state trunkline projects, nine county road construction projects and 12 gravel resurfacing jobs on Upper Peninsula state trunklines are announced by Highway Commissioner Charles M. Ziegler of *Michigan*. The total of the bids is $2,683,213.83, the second largest letting since before the war. As soon as Public Roads Administration approval is received, contracts will be let. In the last 12 months the department has taken bids on work that will cost some $36,000,000.

Water supply and sewerage—*Columbus, Mo.*, is receiving bids on the construction of a $150,000 sanitary outfall sewer and a sewage disposal plant with equipment and auxiliaries. Russell & Axon, St. Louis, Mo., are the consulting engineers. . . . Gov. John O. Pastore of *Rhode Island* has received a recommendation from the state commission on postwar programs that Rhode Island complete the construction of its own sewage disposal plant at the state institutions in Howard, rather than to tie into the existing Cranston system. The recommendation was based on a report to the commission by the Waterman Engineering Co., which has estimated that it would cost the state $17,500 yearly over the next 33 years to operate its own system. A tie-in with Cranston would cost $14,938 per year over the 33-year period. The report stated that a complete disposal plant should have a capacity of 1,100,00 gpd., which could be handled at virtually no extra cost.

Work to get under way on Massachusetts dams

The Kelleher Corp. of Turners Falls, Mass., has begun the initial stages of construction of a rock-filled dam 62 ft. high, 30 ft. in width at the top and 1570 ft. long, on the east branch of the Tully River as a part of the Army Engineers' flood control project in northwestern Massachusetts.

The dam is expected to harness the chief tributary of Millers River and thus protect communities along the banks of the latter stream.

Bids for the project, ranged from the Kelleher concern's low bid of $762,545 to one of $1,138,000.

Another flood control project which may get under way next year is the Ware River Valley Dam and reservoir planned for Barre Falls, four miles east of Barre, Mass. The project when completed will give flood protection to Barre Plains, Old Furnace, Gilbertville, Ware, Thorndike, and Three Rivers. It will also reduce floods on the Chicopee River formed at Three Rivers by the junction of the Ware, Swift and Quaboag rivers.

Army Engineers plan a rock-filled dam 885 ft. long and 62 ft. high. Eventually a lake covering 1520 acres in Barre, Hubbardston and Rutland will be formed.

***Kansas Registration Law Amended**—Compulsory registration for professional engineers is now incorporated into the state laws, as result of a bill pushed through the state legislature by state engineering groups. Kansas' original registration law, passed in 1931, provided for optional registration. Watching Gov. Frank Carlson sign the new bill here are, left to right: C. C. Bradwy, of Columbus, who acted as legislative representative for Kansas Engineers; Rep. Walter McGinnis and State Senator Hal Harlan, and C. Y. Thomas, president of the Kansas Engineering Council and chairman of a joint legislative committee representing all state engineering groups.*

Discuss dangers of Colorado diversion

(*Continued from page* 53)

Stanley, of the reclamation bureau staff at Boulder City, Nev., said. Some four percent of the capacity of Lake Havasu (formed by Parker Dam) has been filled by scour on the river below Boulder Dam, he said. He added that retrogression caused by Laguna Dam has lowered the river to such an extent at the Intake for the Alamo Canal that for much of the year diversion there is impossible.

Sludge disposal by dilution

The results of an investigation carried out to determine the effects of discharging well-digested sludge with plant effluent was discussed in a paper by A. M. Rawn, chief engineer and general manager, and E. J. Candel, plant chemist, Los Angeles County Sanitation Districts, presented by Mr. Rawn before the sanitary engineering division.

It was concluded that where sludge banks will not be formed there is little, if any, reason why such disposal may not be carried out. The character of primary clarifier effluent was not too radically changed in tests made at the districts' plant; the B. O. D. increased some 2.4 percent, chlorine demand increased 4.7 percent, and the grease content increased from 34 to 41 ppm. The influence of adding this sludge to primary clarifier effluent, Mr. Rawn stated, is probably less than the daily variations in the character of the effluent.

Construction division

R. F. Blanks, chief, engineering and geological control and research division, Bureau of Reclamation, urged a concrete aggregate testing and research program "to realize the full potentialities of concrete". Special study is needed on the properties of aggregate contributing to bond with cement and also on thermal expansivity, volume change, and the properties affecting drying and shinkage. He referred to a quick chemical procedure recently developed by the bureau capable of distinguishing deleteriously reactive from innocuous aggregates in connection with use with high-alkali cements. This procedure can be carried through in two days. A prepared sample of aggregate is immersed in a solution of sodium hydroxide for 24 hours at 80°C; the solution is then chemically analized for dissolved silica and titrated with acid to determine the reduction of alkalinity of the solution. By comparing these data, the potential reactivtiy of the aggregate with high-alkali cement can be predicted.

Also presented before the construction division were papers by L. R. Douglass, assistant regional director, Bureau of Reclamation, Boulder City, Nev., who reviewed the history of the Davis Dam project (*ENR* Aug. 22, 1946, vol. p. 230). A. K. Fogg, Capt. CEC USN, who discussed the San Diego Aqueduct (*ENR* March 6, vol. p. 362).

Flood free airports

Airports should be designed so they are not flooded even by storms occuring once in a hundred years according to Edward Koehm, head of the flood control design section and R. J. Shultz, head of the landing fields section, Los Angeles district office, Corps of Engineers. Value of human life and the high cost of airplanes make it mandatory that airports with a high intensity of traffic have at least one runway designed to be free from flooding by such a storm.

R. W. F. Schmidt, Superintendent of Airports, Civil Aeronautics Administration, Santa Monica, Calif., in a paper presented before the air transport division challenged the ability of engineers to design airports just because they are licensed engineers. He decried engineering practice which insists on costly practices merely to gain a few percent on some theoretical figure.

Road Straightened *— Cutting straight across this valley bed in West Virginia's rugged countryside near Hurricane, this 5.8 mi. section of U. S. 60 will be the final link in a new road between Charleston and Huntington. It will reduce some 57 curves to six. Construction contract on the section is held by the Smith and Price Construction Co. of Huntington.*

In a discussion of Mr. Schmidt's paper prepared by A. J. Ryan, consulting engineer, Denver, Colo., and read by R. W. James, Public Roads Administration, Denver, Colo., it was said that too many persons connected with the operational aspects of aviation think they will decide the right type of facility to meet their requirements and that the engineer should use his technical skill in designing what he is told to design.

Other papers presented were by G. W. Marx, director of Sanitary engineering, Arizona Department of Health, who noted the need for 1,000 more sanitary engineers trained in public health and for practising engineers to be more active influential in administrative matters now dominated by medically-trained men; by D. J. Stul, of the Public Roads Administration, San Francisco, on subgrade soil classifications, and by Lloyd Aldrich, city engineer of Los Angeles, on that city's urgent need for more freeways.

Board actions

In approving for submission to the membership the amendment to increase corporate dues by $5 per year, the board heard directors representing metropolitan New York City emphasize the view of members of that district that there is no longer any justification for payment of $5 a year more dues by members in the district. Although the board appeared to be in general agreement with this view, it was understood that an attempt to eliminate the differential at this time might jeopardize favorable action on the general dues increase.

However, as a first step toward ultimate elimination of differentials, the board gave favorable consideration to a proposal that procedure be initiated to make dues of all junior members, wherever situated, $12.50 per year.

Other actions taken by the board included:

A recommendation to the Engineers' Joint Council that steps be initiated for the creation of a commission, charged with investigating the several elements affecting "the orderly and economic development of the water resources of the country", and with making recommendations as to the legislation and administrative organization necessary for such development. This recommendation arose from earlier discussions concerning the problem of the creation of valley authority agencies.

Establishment of the Leon S. Moisseiff Award, to be given to the author of a paper appearing in the Transactions, dealing with the board field of structural design. A fund of some $4,000 donated by members of the society and others was accepted.

New Jersey adopts new road fund policy

Distribution of state aid to be based on traffic density as well as population—Connecticut checks formula

For the first time, New Jersey's large population centers are to share in state aid grants to municipalities for highway construction and maintenance, under provisions of an act passed by the state legislature recently.

Under the new law—sponsored by Gov. Alfred E. Driscoll—density of traffic has been made a factor in determining amount of allocations. Previously, larger cities have been barred from state aid by legal restrictions against advancing money to municipalities of more than 14,000 population.

The legislation provides that municipalities of larger size will share in a total of $4,200,000 appropriated by the state for highway work this year—an increase of $1,050,000 over last year. In addition, counties will receive $8,155,000, of which $6,000,000 will be apportioned on the old basis of road mileage, area and population; $1,000,000 on the basis of population and mileage only, and $1,155,000 will go as outright grants of $50,000 to each of the state's 21 counties.

In addition to using the money for road and bridge construction and maintenance, county freeholders may devote some of the funds to debt and interest of road and bridge bonds, lighting, operation of drawbridges, and policing.

The measure provides a formula for apportioning the money by equating the population of each municipality to the total state population (1940 census), and each municipality's road mileage to the total municipal road mileage in the state. The two resulting percentages are then divided by two, to give each municipality's share of the fund finally approved by the legislature for this purpose.

A minimum and maximum for aid to municipalities is set, and legislators said that no county will receive less than $150,000 by operation of the formula. In addition, the $50,000 outright grant to the counties will provide an additional drawing account for the cities and is expected to permit "subjective judgment" to correct inequalities that may come from strict application of the formula.

The minimum that a municipality may receive is based on the average amount of state aid allotted during the 10-year period 1937-1946. The maximum is set at 38 percent of the municipality's average annual expenditures for the five-year period 1941-45.

While New Jersey prepared to put its new allocation law into effect, Connecticut legislators were considering a new formula for distribution of state-aid funds.

The present system allots $23,668 annual to each town for road improvements. Under a proposal now under consideration, this year's $4,000,000 fund would be allocated on a mileage basis.

Canada will expend $163 million on roads

Publication of the annual budgets of the provincial legislatures and the dominion parliament of Canada shows that a total of at least $163,000,000 will be spent this year for highways and associated construction work. The province of Ontaria accounts for well over one-third of the total, $63,000,000 having been included in its budget for road and bridge construction, and for maintenance charges and subsidies to municipalities and counties, following the recent change in provincial highway financing (*ENR* Mar. 27, vol. p. 477). Quebec's allowance for roads is just over $30,000,000.

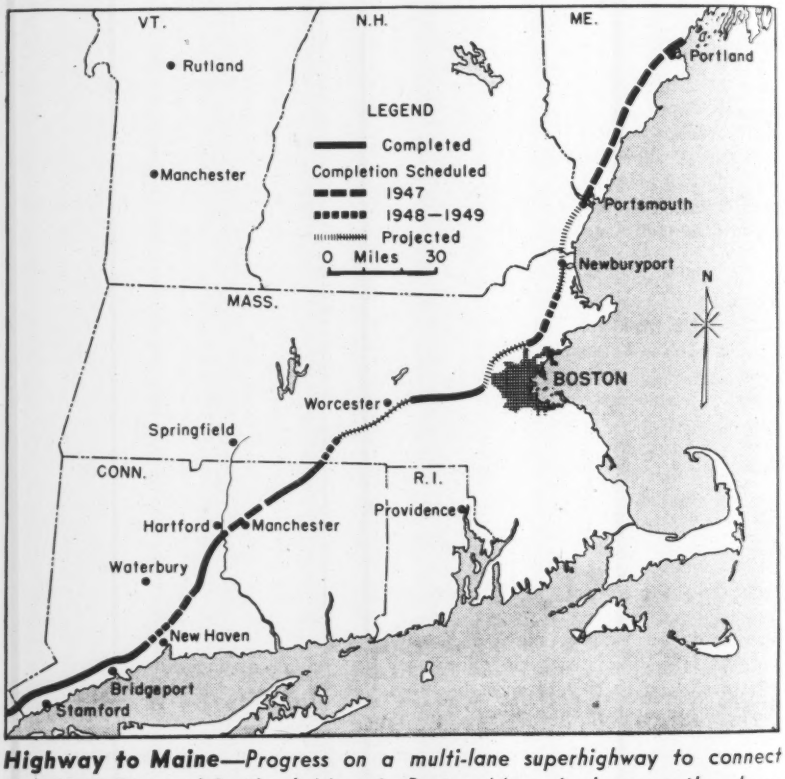
YOLKS JOLTED

The effect of dynamite on the chicken-producing qualities of eggs became a matter of concern to engineers of the Connecticut State Highway Department last week.

To their considerable surprise, they found themselves involved in this delicate point in poultry-raising when a farmer in Old Lyme filed a claim against the department, charging that blasting for a new road near his incubators had caused a 60 percent loss in the number of eggs hatched. He asked $1,500 damages.

Engineers ferreted into libraries and other sources of information and finally told the claims committee of the state legislature that they had found evidence that incubating eggs should be turned frequently.

No mention of the use of dynamite for this purpose was found, however.



***Highway to Maine**—Progress on a multi-lane superhighway to connect New York City and Portland, Me., via Boston, Mass., is shown on the above map, released recently by the New England Council. The Merritt Parkway in Connecticut on the southern end, is completed, as are several other sections of the road, and the Maine Turnpike, from Portsmouth to Portland is already under construction. Under state plans so far announced, about 150 mi. of the highway will be a toll road, while the remaining180 mi. will be free.*

Clay pipe workers strike over wages

Sewer pipe production tied up in three states—Construction labor demands for raises continue

More than 2,800 clay workers employed in 22 sewer pipe manufacturing plants in Ohio, Indiana and eastern Pennsylvania are back at work, after a 13-day strike over demands for a 12 cent per hour wage increase and other concessions.

The strike, which may have repercussions on a market where clay pipe products continue in short supply, was one of many labor disturbances affecting the construction industry.

The clay workers are members of the United Brick and Clay Workers Union (AFL). Striking against plants owned by 16 companies, they asked, in addition to the 12 cents per hour boost, concessions on a parity with increases granted to steel unionists in recent negotiations held with the major steel producing organizations. The companies approved the boost. Four other clay products plants in the union's district remained in operation, by virtue of contracts recently signed which grant most of the union demands.

Other developments

Meanwhile, the already confused construction labor picture showed no signs of clearing, as scattered reports of settlements and new strikes continued to be submitted.

In Indianapolis, Ind., a walkout of more than 2,000 union carpenters threatened to bring to a standstill work on industrial construction valued at more than $15,000,000 and hampered housing construction. Carpenters demanded a $2.00 per hour wage scale. At Crawfordsville, Ind., failure to grant a wage increase of 20 cents an hour to members of the Hod Carriers and Laborers Union caused about 200 men on three construction jobs to walk off the sites in a week-long strike now settled by raises.

And at Portsmouth, Ohio, carpenters were granted pay boosts of 12½ cents per hour, but remained off their jobs through refusal to cross picket lines set up by striking hod carriers.

Settlements

Among the disputes settled, or offers of raises made, were:

At Omaha, Neb., contractors agreed to raise the pay of bricklayers from $1.82 per hour to $2.10; carpenters from $1.62½ to $1.82½; plasterers and lathers from $1.75 to $2.00.

The Ashtabula, Ohio, Master Plumbers Association offered its employees a 12½ cent an hour increase for journeymen; and at Bridgeport, Conn., a building trades strike was settled by approval of wage boosts approximating 25 cents per hour for most grades of labor.

Missouri bill passes

On the legal side of the labor question, the Missouri House of Representatives April 23 passed a bill to outlaw strikes in public utilities.

Approved by a two-to-one majority, the bill provides for seizure of utilities threatened with work stoppages due to labor trouble, and permits injunctive action by courts to enforce its provisions. It makes it unlawful for any employee to participate in any strike or concerted refusal to work for a public utility in a labor controversy, or to strike after the state has taken over the plant. Employees violating provisions of the measure would lose seniority rights, and labor unions would be subject to fines of $10,000 per day for each day of illegal strike, and union officers would be liable for fines of $1,000. The companies would be subject to fines of $10,000 per day if found guilty of a lockout.

Redesignate Fort Belvoir engineering facilities

U. S. Army Engineer research and development facilities of the Engineer Board at Fort Belvoir, Va., have been redesignated by the War Department as the Engineer Research and Development Laboratories.

The Engineer Board, however, will continue to function as the directive and policy-making body for the laboratories, the announcement said. The change in name was made to clarify the status of the scientists and technicians who conduct research and development work at the installation. Previously, the board, the laboratories and facilities all bore the same name.

The change is also part of a recent reorganization at Fort Belvoir in which all Army activities there were consolidated under a single headquarters with the establishment of the The Engineer Center, under command of Maj. Gen. W. M. Hoge. Previously, engineer research and development activities at Belvoir were administered directly by the Office of the Chief of Engineers.

PERSPECTIVE . . . . .

Practicing Under a Firm Name

New Yorkers were considerably mystified last week by a newspaper headline stating that the well-known architectural firm engaged by the Engineers' Club to remodel its clubhouse was "illegally practicing architecture."

It all came about through efforts of the architectural profession in New York State to give effect to a provision of the architects' license law designed ultimately to eliminate the practice of architecture in the name of a firm rather than by individuals. Similar provisions are included in the engineers' license law for New York and in many other states.

When the architects' law was passed about 20 years ago, it limited licenses to individuals approved by the licensing board, but included a "grandfather clause" exempting firms legally practicing as architects at that time. The firm of Thomas W. Lamb, Inc., architects of the old Hippodrome, the present Madison Square Garden and other well-known buildings, was one of the exempted organizations. Mr. Lamb died in 1942, and the firm subsequently went into bankruptcy, according to the assistant attorney general who is pressing the state's case against the firm. The suit is very involved legally, centering on a determination by the courts of whether the firm actually suspended business while in bankruptcy.

There are factors that make this action appear to many to be merely a tempest in a teapot.

On the part of both engineers and architects, these provisions of their license laws stem back to a desire to keep unlicensed individuals from getting control of a firm with an established name and continuing to seek business on the basis of that reputation long after the individuals who built that reputation have passed on. But as most, if not all, license laws also require that the chief executive officers of corporations or the members of firms or co-partnerships continuing to practice under the "grandfather clause" must be licensed engineers or architects, the possibility that "life, health or property" will be endangered by such continued practice appears so improbable as to raise serious question in the minds of the public as to the need for spending the state's money in prosecuting suits of this kind in the courts.

HIGHLIGHTS OF MUNICIPAL DEVELOPMENTS

Propose elevated road at Wilmington—Philadelphia prepares for underground parking garages—Sewerage plans announced

Construction of an elevated highway over the east side of Wilmington, Del., as an essential part of approaches for the Delaware River bridge soon to be built has been suggested to the municipal authorities.

The highway would connect the northern and southern sections of Governor Printz Boulevard and provide a much needed additional bridge over the Christina River.

Also recommended is the development of clover leaf intersections, overpasses and other means of regulating the flow of traffic to and from bridge approaches.

Other projects

Among other proposed municipal highway improvements brought out last week were:

At Birmingham, Ala., highway work to cost about $3,600,000 has been assured with contracts to be let in July.

Contracts for the $2,000,000 First Avenue overpass, the $1,100,000 Avondale-Irondale superhighway, the $95,000 widening project on First Avenue near Woodlawn definitely will be let before July 1. This will include the completion of the $400,000 Birmingham Port Road, from Mulga Loop to 19th St.

Proposals of Mayor deLesseps S. Morrison, of New Orleans, La., for civic improvements bonds carried at a recent special election by a good majority. Approved were $12,000,000 for grade separations and $10,000,000 for street improvements.

The highway department of the District of Columbia April 11 awarded a $3,294,392 contract for an elevated highway along K Street from Key Bridge to 27th Street, N. W., in Washington. The contractor is Alexander & Repass of Des Moines, Iowa, the lower of two bidders. Work will start in June.

Work on a $500,000 to $600,000 underpass to eliminate a grade crossing at Moreland and DeKalb Avenues in Atlanta, Ga., probably will be started this year as a result of recent conferences between city and state highway officials; Montgomery, Ala., plans to call for bids on 140 blocks of street paving at a cost of $500,000.

Sewer work planned

Sewerage and sanitary works continue to be the forefront of municipal planning and activity. The week's developments included:

Letting of a contract for work on the southwestern main sanitary sewer at Oklahoma City, Okla., was postponed to await a report by the engineering advisory council on bids submitted. The city plans three large main sewers.

Sewer improvements costing about $1,420,000 were authorized April 10 by Mayor Robert H. Tyndall's sewer committee at Indianapolis, Ind.

At Phoenix, Ariz., bids for an estimated $1,000,000 enlargement of the municipal sewage treatment plant to, boost present 10 mgd. capacity to 30 mgd., will be opened May 19.

Discuss regional plan

The committee on Cities and Boroughs of the Connecticut General Assembly has favorably reported a bill which would set up a Bradley Region Zoning Authority for Windsor Locks, Windsor, Suffield and East Granby. It would consider all zoning and planning problems growing out of the expansion and operation of Bradley Field, to be developed for international service. The act, when passed by the legislature, must be approved at town meetings.

Zoning plan approved

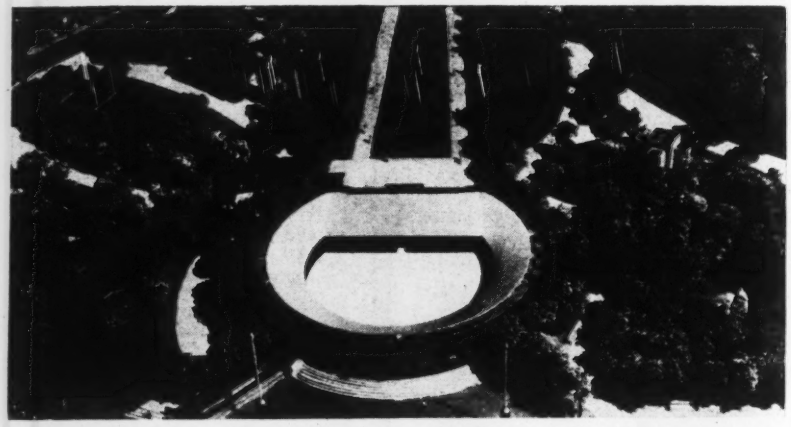
A new city-wide zoning ordinance for residential and apartment construction has been enacted by the Jackson, Miss., city council. Effective at once, it divides dwelling units into three classes: (1) Exclusive one and two-family houses, (2) limited apartment and (3) unlimited apartments. One and two-family houses must be on lots with a 50-ft. frontage and 7,500 sq. ft. of area set back at least 25 ft. They must not exceed 35-ft. in height and may not occupy more than 20 percent of the ground area. In the limited apartment area at least 2,000 sq. ft. or land must be allowed for each family unit.

Unlimited apartments must be set back at least 5 ft. from the sideline on the first three stories, and all above the third floor additional shall be calculated at one ft. for each 10 ft. in height to set back.

Phila. tackles parking

The way has been cleared for Philadelphia, Pa., to construct underground parking facilities in its central section, since Governor Duff has signed the legislative bill permitting it. Mayor Bernard Samuel announced that $3,000,000 is available for the projects.

Meanwhile, the Philadelphia Committee for the Relief of Traffic Congestion reported to City Council that it advised the construction of an underground parking garage beneath Rayburn Plaza and a 3-story and basement surface garage in the block bounded by Chestnut, 10th, Ludlow and 11th Sts. The committee estimated that the cost of the 2-story sub-surface garage would be from $2,365,650 to $2,838,780, while the estimated cost of the surface garage was put at $2,127,426. The Plaza lot would have facilities for 900 automobiles and the surface garage will have room for 840 automobiles. City Council already has an ordinance to appropriate $50,000 for the sub-surface garage, and is awaiting the traffic committee's findings before appropriating funds.



***Memorial for New York**—The New York City Board of Estimate is considering plans for a "Fort Clinton Memorial" to be built in Battery Park at the southern tip of Manhattan Island, to replace old Fort Clinton (better known as the Aquarium) which has been demolished during construction of the Brooklyn-Battery tunnel.*

Ten-to-one House vote approves cut in Interior Department's 1948 funds

Senate committee takes up budget measure that slashes $134 million from requests. Bureau of Reclamation planning activities are jeoparized by drastic cut.

Bureau of Reclamation and other Interior Department construction agencies will appeal to the Senate within a few days for additional funds for their activities during fiscal 1948. The Senate Appropriations Committee this week took up Interior's annual appropriations bill, which was passed unexpectedly by the House last week.

The House version, approved by a 307 to 30 vote of its members, slashed some $134 million from $295 million requested

A subcommittee, headed by Sen. Kenneth Wherry of Nebraska, may add some funds to the bill, which was cut by the House along strict economy lines. Major efforts to increase allotments for western reclamation projects and other works are expected on the Senate floor, where most major additions to Interior appropriations have been made in recent years.

House action on the measure followed closely the recommendations of the House Appropriations Committee (*ENR* April 24 vol. p. 703). With surprisingly little debate, the bill went through with a net increase of only $4,875,000 over the committee's figures, raising the total for the department from $156,538,513 to $161,413,513.

Additional funds aggregating $5,175,000 were voted for the Bureau of Reclamation and $150,000 for the Fish and Wildlife Service, but $450,000 was cut from the Bureau of Mines.

A few projects favored

Specific projects of the Bureau of Reclamation that gained new funds were: Colorado—Big Thompson, increased $2,000,000 to a total of $6,815,000; Anderson Ranch Dam, Idaho, boosted $1,000,000 for a total of $3,874,000; Columbia Basin, Washington, up $2,000,000 to a total of $11,435,000, and the Glendale Project, Wyo., previously unprovided for, $175,000.

Western congressmen of both parties sought increased funds for practically all reclamation projects, the Bonneville Power Administration and the Geological Survey, and there was considerable debate over Reclamation's allotments for general investigations, the Central Valley Project in California, Davis Dam in Arizona, and the Hungry Horse project, Montana. But the House refused, in repeated voice votes, to increase funds for these.

All planning jeopardized

Meanwhile, Bureau of Reclamation spokesmen predicted a general slowdown on virtually all major construction projects unless the Senate adds to the bureau's appropriations.

Limitation of general investigation funds to the $125,000 authorized by the House would halt work on all river basin reports now in preparation, stop field work and completion of reports on several hundred individual projects, and completely liquidate the bureau's general engineering and planning staff, these sources advised.

Reduced sums now provided for the bureau's 1948 construction program, they added, will have the most adverse effects upon major irrigation and power projects, such as the Central Valley, the Columbia Basin and Missouri Basin developments.

Groundwater work is out

The Geological Survey, which has asked for $3,750,000 for gaging streams and for related water supply investigations, was restricted to $2,578,680. Furthermore, the House prohibited the use of any funds for "cooperative or non-cooperative groundwater activities" with states, counties or local communities.

Such activities have been opposed by private well-drillers, one association terming them a "bureaucratic usurpation of functions carried out successfully by private industry."

Geological Survey spokesmen, on the other hand, claim that their cooperative groundwater work with local units of government is essential to the coordination of basic data of national interest. They point out that specialized personnel, totaling some 260 men, will have to be dropped.

House banking committee reduces re-use housing

The House Banking Committee last week voted to reduce the veterans re-use temporary housing program by 3,730 units. The group approved a bill authorizing the Federal Public Housing Administration to spend $35,500,000 more to complete its cut-back program. The original bill would have authorized $50,000,000.

FPHA officials explained that the funds authorized in the bill would permit the completion of 8,300 units and provide $500,000 to reimburse states and municipalities for amounts spent in preparation for the 3,730 units that will be dropped. The measure would increase the total cost of the program to $445,500,000.

***Louisiana Dam in Operation**—The first single-purpose reservoir in Louisiana's Red River Valley flood control program is Wallace Lake Reservoir, 14 mi. southeast Shreveport. Built and operated by the Corps of Engineers, actual construction started in 1942, but was suspended during the war. Completed recently, the dam cost $1,250,000, is of earth fill, 200 ft. average width at base and 4,934 ft. long, with a maximum height of 48 ft.*

AWWA section announces Goodell Prize winner

Louis R. Howson, of the engineering firm of Alvord, Burdick and Howson will receive the John M. Goodell Prize for 1946 from the American Water Works Association it was announced at Chicago during a meeting of the Illinois section April 17-18. The award honors the late Mr. Goodell, editor of *Engineering News* from 1903 to 1912.

The national organization award is made annually to the member who has made "the most notable contribution to the science or practice of waterworks development" — usually as recorded in the form of a paper published in the association's journal. Mr. Howson's prize-winning paper, "Guides and Checks on Water Works Operations," was published in the January, 1946, issue of the journal.

Georgia will match federal road funds

M. E. Thompson, the new governor of Georgia, has told the state highway board that his administration will pave no roads unless matching federal funds are available.

By putting into effect a program of strict economy, he said, the state will be able to match every dollar of some $11,000,000 in federal funds available to Georgia this year and a like amount next year.

The governor urged elimination of all unnecessary jobs in the highway department, consolidation of departments and firing of all "padded" personnel as the first step in economies.

Correction

Prof. A. T. Granger, head of the department of civil engineering at the University of Tennessee, has called attention to certain omissions in a description of the stadium-dormitory at that institution. (*ENR* Apr. 10 vol. p. 547) The only portion of the structure which is not already constructed is the curved part in the foreground which will unite the two existing straight side sections in the form of a U. The present seating capacity is approximately 28,000 including temporary stands at the far end of the field. There are also dormitory rooms under part of the present stands which accommodate 200 students.

When completed, the total seating capacity will be about 48,000 and housing will be available for approximately 700 students.

Plan flood control work in Pennsylvania

By unanimous vote, the Pennsylvania Senate has passed a $10,000,000 appropriation to finance a flood control and reforestation program.

The bill, which went to the House, would allocate the money to the Department of Forests and Waters to make effective Gov. James H. Duff's recommendation "to carry on vitally needed and long neglected work of flood control and conservation of water resources."

The apropriation also would be available for development of state parks and recreational areas and for expansion of the commonwealth's flood forecasting service.

The Senate previously approved a companion bill.

Navy seeks civilians for engineering posts

The Navy Department last week announced it was seeking a number of civilian recruits for its engineering organization, in grades in a salary range between $3,400 and $10,000. Civil engineers, mathematicians and physicists are among those sought.

Applications for information may be directed to Room 1205 Main Navy Building, 17th St. and Constitution Ave. N. W., Washington, D. C.

***Old Timer**—Paul W. Maetzel (left) city engineer of Columbus, Ohio, shows Orris Bonney, deputy engineer, an example of some of the first machine-made clay pipe ever produced. The pipe, unearthed in recent excavation work, apparently was made on a special machine invented in 1849 by C. J. Merrill of Akron, Ohio. Used for small water and sewer pipe, the conduit was made in a mold and the opening bored through. Flanges were made by hand and fired integrally with the body.*

Oregon farmers' petition delays new power law

A preliminary petition for referendum on a bill passed by the Oregon legislature permitting power companies to retain their dams for the period for which they were licensed has been filed. Signers of the petition are officers of the Oregon State Grange and the Oregon Farmers' Union.

As a result of this action, operation of the law is deferred until after the 1948 general election, when voters will pass on the legislation, provided completed petitions contain the names of 11,856 qualified voters.

The bill, sponsored by eastern Oregon legislators, was passed by the legislature over the veto of Gov. Earl Snell. Its immediate purpose was to clear the way for construction of a $12,000,000 dam on the Snake River by the Idaho Power Co. to relieve a power shortage. Public power advocates bitterly opposed the bill during legislative hearings.

To start new power plant for Ontario Hydro

Another new water power project—to cost an estimated $19,000,000—is to be started immediately by the Hydro Electro Power Commission of Ontario, according to an announcement of Premier Drew.

The new project is located on the Mississaga River in the Algoma district, 20 miles north of Thessalon and 50 miles east of Sault Ste. Marie. It will generate 56,500 hp. The plant will generate 60-cycle power, some of which will be fed into a frequency changer (to 25-cycle power) at Sudbury, as the output of the station is for use in the mining district of Sudbury-Nipissing, at present served by both 25 and 60-cycle power. The main dam and power house will be built in a rocky gorge, 90 ft. deep, river flow being temporarily diverted by means of a rock tunnel. Operating head will be 215 ft. A storage dam will be built 40 miles upstream at Rocky Island Lake to assist in regulating river flow.

This is the fifth major water power project to be undertaken recently by the Ontario Hydro, other plants now under construction being at Des Joachims on the Ottawa River, at Stewartville on the Madawaska River, a tributary of the Ottawa, an extension of the new De Cew Falls plant on the Niagara escarpment, and a new plant on the Aguasabon River north of Lake Superior.

OBITUARY

Noel W. Smith, 77, who retired in 1939 as assistant chief engineer of the Pennsylvania RR and who was general manager of the Alaska Railroad from 1924 to 1928, died April 11 in Byrn Mawr, Pa. After graduation from Lehigh University in 1893, he entered the Pennsylvania's employ as an engineer. In 1909 he became division engineer at Altoona, where he subsequently was made superintendent and general superintendent. At Government request he was given a leave of absence to analyze the affairs of the money-losing Alaska Railroad, and later was made general manager. Returning to the Pennsylvania he was named general superintendent of motor service and finally assistant chief engineer in 1929.

Clark Evans Disher, 64, president of the Disher Steel Construction Company Ltd., Toronto, Ont., died on April 18.

Rene A. Richard, 59, civil engineer associated with Charles T. Main Co., consulting engineers, Boston, Mass., died April 19. He was a graduate of Laval University, Quebec, and of Massachusetts Institute of Technology.

David Orr Johnson, 76, president of Johnson Brothers Ltd., general contractors at Brantford, Ont., died April 16 at that city.

Dewey A. Harris, 49, construction engineer with the Norfolk Construction Co., died April 15 at South Hill, Va.

Lester S. Ready, 58, San Francisco consulting engineer, died April 9 in Fresno, Calif. An employee of the California Public Utilities Commission from 1912 to 1927, he became president of Key Transit System, Oakland. At the time of his death he was consultant for the Kings River Water Users Association and the Sacramento Municipal Utility District and was a member of the California Water Resources.

Joseph A. Kitts, 66, Nevada City, Calif., construction engineer, died there recently. A graduate of the University of California in 1909, Kitts was employed in the building of the Panama Canal and was awarded the Theodore Roosevelt Panama Canal medal with two bars for his work there. He later became a California state highway construction engineer. A concrete technologist, he wrote "Specifications For Structural Concrete."

John W. Mueller, 62, of Richmond, Ind., died April 19. A pioneer in the construction of reinforced concrete structures, he was serving as consulting engineer for the Richmond Municipal and Lighting Power plant at the time of his death.

Robert L. McCormick, 80, Brazil, Ind., for 46 years on the faculty of Rose Polytechnic Institute, died April 10 in Terre Haute. He was professor of civil and architectural engineering and headed the civil engineering department for several years prior to retirement. A consultant on steel and concrete structures, with the late M. A. Howe, he designed the Wabash Avenue bridge over the Wabash River in Terre Haute. Prof. McCormick was graduated from Rose Polytechnic Institute in 1891, and was a member of the first Indiana Board of Registration for Professional Engineers and Land Surveyors.

Joshua S. Sawyer, manager of the asphalt department of the Shell Oil Co., New York, died April 6. He formerly was a division engineer with the Oregon State Highway Department.

Conrad Hewitt, 81, formerly superintendent of buildings for the Metropolitan Museum of Art, New York City, died April 25. He was a civil engineer graduate of Princeton University, 1888, and began work with the New Jersey Sheet and Iron Co. of Trenton. Later he formed a construction firm, and his work with the museum started in 1920 and lasted till his retirement in 1937.

MAJOR MEETINGS

National Rivers and Harbors Congress, 37th convention, U. S. Chamber of Commerce Bldg., Washington, D. C., May 2-3.

American Society of Planning Officials and Association of State Planning and Development Agencies, Cincinnati, Ohio, May 5-9.

United States-Mexico Border Public Health Association, annual meeting, San Diego, Calif., May 6-8.

Society for Experimental Stress Analysis, annual meeting, Stevens Hotel, Chicago, Ill., May 15-17.

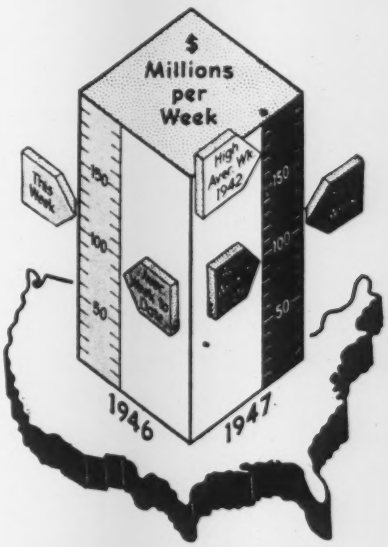
Associated General Contractors, spring meeting, governing and advisory boards, Olympic Hotel, Seattle, Wash., May 19-21.

American Shore and Beach Preservation Association, 21st annual meeting, The Berkeley Carteret, Asbury Park, N. J., May 27-28.

American Society for Testing Materials, 50th annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 16-20.

American Society of Engineering Education, annual meeting, University of Minnesota, Minneapolis, Minn., June 17-21.

CONSTRUCTION ACTIVITY



As Reported this week to . . .
Engineering News-Record

CONTRACT VOLUME

Continental U. S. Only
(Thousands of Dollars)

	Week of May 1 1947	Cumulative 1947 (18 wks.)	Cumulative 1946 (18 wks.)
Federal	$14,648	$168,123	$184,625
State & Mun.	33,108	513,782	369,302
Total Public	$47,756	$681,905	$553,927
Total Private	54,724	1,062,922	1,071,355
U. S. Total	$102,480	$1,744,827	$1,625,282

WHERE CONSTRUCTION ACTIVITY ORIGINATED THIS WEEK

Dollar Volume (Thousands)

Type of Work	This Week	Cumulative 1947 (18 wks.)	Cumulative 1946 (18 wks.)
Waterworks	$963	$44,459	$33,836
Sewerage	1,857	31,363	20,291
Bridges	2,507	53,676	40,034
Highways	22,976	225,176	204,864
Earthwork, Waterways	8,911	92,320	102,089
Buildings, Public	8,370	167,927	100,741
Industrial	12,884	277,063	352,094
Commercial	27,245	640,401	647,612
Unclassified	16,767	212,442	123,721

NOTE: Minimum size projects included are: Waterworks and waterway projects, $22,500; other public works, $40,000; industrial buildings, $55,000; other buildings, $205,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1947 (18 wks.)	Cumulative 1946 (18 wks.)
NON-FEDERAL	$573,374	$320,628
Corporate Securities	203,454	134,239
State and Municipl	369,920	186,389
FEDERAL		158,320
Total Capital	$573,374	$478,948

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	May '47	396.49	190.59
Building Cost	May '47	299.61	161.96
Volume	Apr. '47	247	108

EDITORIALS

VOLUME 138 NUMBER 18

May 1, 1947

Firm Prices for Materials

CONTRACTORS are asked to bid on projects requiring a firm price for materials to be delivered several months hence but, at present, get from most suppliers only a promise to deliver at prices current on date of invoice. This condition is a major factor in increasing construction costs for, forced to guess what his materials prices will be on delivery, the contractor guesses high enough to protect himself. If the higher costs do not materialize, the contractor, of course, makes an added profit, but by the same token if his guess is too low, he loses. It is an unhealthy situation that could be greatly improved by firm prices on materials, and now that the steel industry, for example, has a work contract for two years, with wage rates fixed for at least a full year, it should soon be able to determine its cost for manufactured products and to give a firm price with a reasonably certain delivery date. Manufacturers of other construction materials are now, or soon will be, in a similar position to quote firm prices. Once they do, contractors can dewater their bids substantially, a most important factor in bringing down the cost of construction.

The Reclamation Budget

ACTION BY THE HOUSE in slashing the budget of the Reclamation Bureau by more than half, cannot be too seriously appraised until the Senate records its position. The winds of politics have not yet had a chance to blow away the haze surrounding 1948 horizons. And it is these winds and those horizons that profoundly affect the size and shape of certain federal budgets. There are two aspects of the Reclamation Bureau's budget cut, however, that compel attention. In voting a substantial reduction in construction activity, the House would seem to be on sound ground; it recognizes that with present high costs for construction, many of the projects would lose their claim to economic feasibility. On this latter criterion, it must be remembered, rests the primary justification for executing a project. But although it is proper to postpone some construction the same reasoning cannot be carried to general investigation work, which is practically eliminated with a slash from $5,000,000 to $125,000. The term "general investigations" covers the planning operations of the Reclamation Bureau, and without long-term planning it is in the position of a ship without a rudder. Equally serious is the fact that valuable members of the crew would have to abandon the ship. To recruit them again might be impossible. There is every expectation, from a political standpoint if none other, that Congress will juggle the budget cuts considerably before they are finally approved. In the juggling one can hope that it will take a dispassionate and national-interest viewpoint of some of the items, and particularly of the one relating to general investigations.

New Home for ASTM

CIVIL ENGINEERS and construction men can mark with satisfaction and applaud with congratulations the acquiring of a home of its own by the American Society for Testing Materials. No technical organization serves better, works harder or has a clearer view of its responsibilities than the ASTM. From its compact and imposing building on Philadelphia's Logan Square will continue to flow the specifications and test procedures that user-manufacturer cooperation devise, and that virtually guide American industry. It is a good omen for the future.

Continuing Vigilance Needed

THE NORTWESTERN SECTION of the ASCE deserves high commendation for its prompt action in getting the Minnesota legislature to kill a bill that would have required the state highway department to specify the use of 15 percent of natural cement in all concrete used for the state's highways. In opposing the bill the section made it quite clear that it had no objection to the use of natural cement. What it was opposed to was writing specifications for concrete mixes into law. Similar instances of undesirable legislation designed to favor a special group can be found among the bills offered to state legislatures every time they are in session, but in many instances the unfavorable aspects are not so obvious as they were in this instance. Many of these bills are of direct interest to engineers, which means that the

engineers of every state need to set up a system for quick and continuing review of what is dumped into the legislative hoppers. Such reviews take time and money, but they are well worth the cost.

The Panama Canal Studies

HISTORY is repeating itself in Panama. An earlier generation of engineers wrote the first chapter, and a glorious story it is. Always read, however, with a detachment akin to that with which one approaches the Roman aqueducts, the Gothic cathedrals, early railroading or the building of the Brooklyn Bridge, few engineers could have imagined that their own generation would have to supply the counterparts of a Stevens or of a Goethals. Yet that is the potential situation today, and it exists, not in some new and untried arena, but on the same project that these earlier engineers made famous. The Panama Canal must be rebuilt to fit it to the future. That is the inescapable conclusion from the engineering studies currently in progress under orders from Congress, as analyzed in an article in this issue.

History is repeating itself because, although we are prone to forget it, no engineering project is built for all time. The Erie Canal, a marvel of its age, was completely reconstructed by a later generation as a part of the New York State Barge Canal system. The railroads of today bear only a slight resemblance to those early transcontinental lines whose construction taxed the ingenuity, courage and skill of their builders. The Brooklyn Bridge must soon undergo a transformation or become merely an antique engineering monument. And so it goes. Changing times and requirements have now caught up with the Panama Canal.

The decisions to be made and the problems to be faced by the investigators, and then by Congress and the American people, are no less difficult and challenging than those of four decades ago and earlier. Some of them, indeed, are the same problems, and here again history repeats itself. Is a sea level or a lock canal the best solution? Have we the plant and the know-how to excavate and move the tremendous yardage of material necessary? Can we cope with the menace of earth slides? Are tide locks necessary in a sea level canal? And how much can we afford to spend?

These questions plagued the early builders. They answered them satisfactorily then, and today we are in an even better position, thanks to increased technical knowledge, better equipment and 35 years' experience with the Canal, to choose adequate ways and means for their solution. But today there is a new, unprecedented problem to be resolved: How can the canal be fitted to an A-bomb age? Adequate means of defense has always been an important consideration for the Panama Canal, but whereas battleships and long-range guns sufficed at first, later supplemented by air cover and protective encasement of vital parts of the locks, today the atom bomb and guided missiles make all such precautions puny.

First, therefore, we must decide what possible facilities can make the Canal safe in the future, and then we must decide if they justify their cost. Here, history again repeats itself, because it was principally on the basis of cost that the present lock type of canal was chosen over a sea level type by the Congress in the early years of the century. Then, however, the decision was fairly easy, for only the capacity of the canal to carry traffic was involved. Today, to adequate capacity must be added security from quick and complete destruction. Under the circumstances, costs have a quite different aspect, although they are still costs just the same.

The significant point is that the time for decision is rapidly approaching. Congress asked for the engineering report before the end of this year. It appears certain that the report will be all that Congress could ask for in respect to technical competence, full details and objective conclusions, within the framework of the request for advice on a canal that will meet the future needs of interoceanic commerce and national defense. The Congressional decision, therefore, can be based on sound and careful reasoning, as befits a project of such vital national importance.

Regardless of what decision is made, however, the Panama Canal will become once again a major responsibility of a generation of engineers. Within a period of 10 or 15 years they must write a second chapter to the history of one of the world's greatest engineering achievements, and it may well relate to the world's greatest construction operation.

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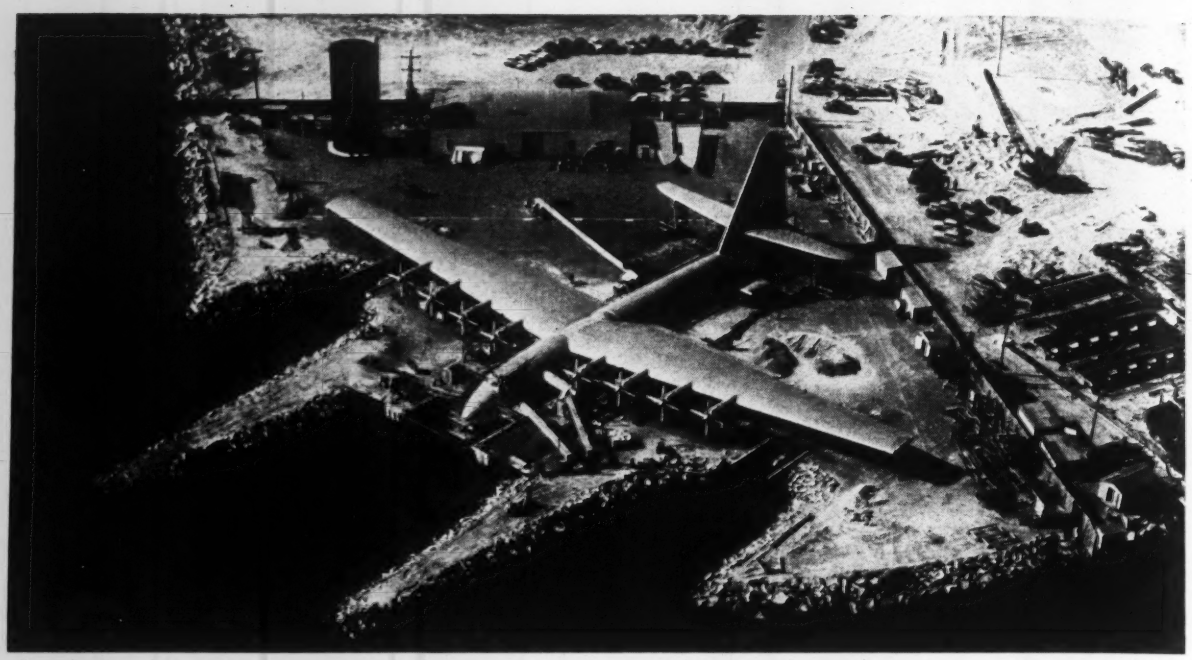

Fig. 1. This giant flying boat is berthed in special drydock facilities built for final assembly and permanent mooring.

Drydock for a Giant Flying Boat

***Contents in Brief**—Design and construction of a drydock of unusual type on Terminal Island, Calif., was required to provide for final assembly and permanent mooring of a 220-ton, eight-engine flying boat built by the Hughes Aircraft Co. The bottom concrete slab for the hull dock is 5 ft. thick and it was poured 6 in. higher than final grade to allow for future settlement. Separate docks for the wing floats are provided.*

DRYDOCK FACILITIES built expressly for a giant flying boat being constructed by the Hughes Aircraft Co. were required for final assembly and as a permanent maintenance base for the plane. With a wing span of some 320 ft., this eight-engine plane is said to be the largest heavier-than-air craft ever constructed. The drydock for the hull of the ship was built 6 in. higher than the final desired grade to allow for future settlement. Special consideration was given to support of the plane during launching and docking.

Originally conceived during the war, the plane is an experimental model jointly financed by the government and Howard Hughes. The eight engines are each 3,000 hp. and the gross weight of the plane is about 220 tons. Framework and all exterior surfaces of the plane are made of wood.

Individual elements of the plane were fabricated at the Culver City, Calif., plant of the Hughes Aircraft Co. However, facilities for final assembly had to be provided near water so the ship could be readily launched. A drydock system was considered best suited for such operations. It is believed that all previously built flying boats were placed on dollies or cradles and hauled up a ramp out of the water for servicing and that this drydock marks the first time such facilities were made to order for an aircraft.

Several factors had to be considered in selecting the location for the drydock. The combination of both inner and outer breakwaters at Los Angeles Harbor will protect the plane at all times from heavy seas. The site is accessible from both land and water and adequate maneuverable water area with favorable alignment to prevailing winds is likewise available.

Use of a drydock will facilitate access to the craft by service crews. The dock is recessed to such an extent that when the plane is in it. wing—and tail surfaces are only a few feet above the surface of the ground. This reduces the cost of final assembly and gives the plane protection from strong winds. In a drydock, danger of damage to the hull is lessened during launching and docking because easy contact can be made between the ship and its supporting cradle.

Separate docks for wing floats

Three individual drydock units are required to berth the flying boat—one for the hull and two for the wing floats. Inside dimensions of the hull dock are width, 35 ft., and length, 237 ft. The slab for this dock is a spread footing with a total width of

57 ft., including a cantilever overhang on each side. Thickness of the slab is 5 ft., and it is reinforced to resist both internal and external pressure. The slab was placed on a layer of crushed rock 12 in. thick. Walls on the hull dock are 21 ft. high and have a tapered section, being 27 in. thick at the bottom and 12 in. thick at the top.

The bottom slab of the hull dock was poured in 30-ft. sections and the side walls in 28-ft. sections. The first sections poured were those farthest from the water and construction progressed toward the water. In placing the bottom slab, subsidence was taken into consideration. The bottom slab as a whole was poured 0.5 ft. above grade and during the first 9 months it settled 0.47 ft. The dock was in use part of this time.

Individual 30-ft. bottom slab sections were poured with the seaward edge of the pour 0.06 ft. higher than the other edge. However, due to local settlement during the pour, the finish elevation of the seaward edge was 0.06 ft. lower.

Wellpoints keep work dry

The drydock site was excavated by dragline cranes and the resulting embankment had 2 on 1 slopes. Although very close to tidal water, no special cofferdam construction was required. However, extensive use was made of wellpoints to keep the work in the dry. Headers completely encircled the dock excavation with individual wellpoints spaced on 4-ft. centers.

In spite of continuous pumping during construction, much difficulty was encountered with local mud-heaving due to the weight of the concrete in the excavation. One of these boil-ups came through the cantilever arm of a bottom slab section while it was being poured. The pour was continued without regard to the mud intrusion. The following day, after concrete had assumed its initial set, a hole was drilled in the slab and concrete pumped in through a 3-in. pipe. In another instance a mud upsurge started while a slab was being poured but it was kept under control by finishing the pour before damage could be done.

The side walls were built in 28-ft. sections by use of one set of forms made of a plywood facing on a steel

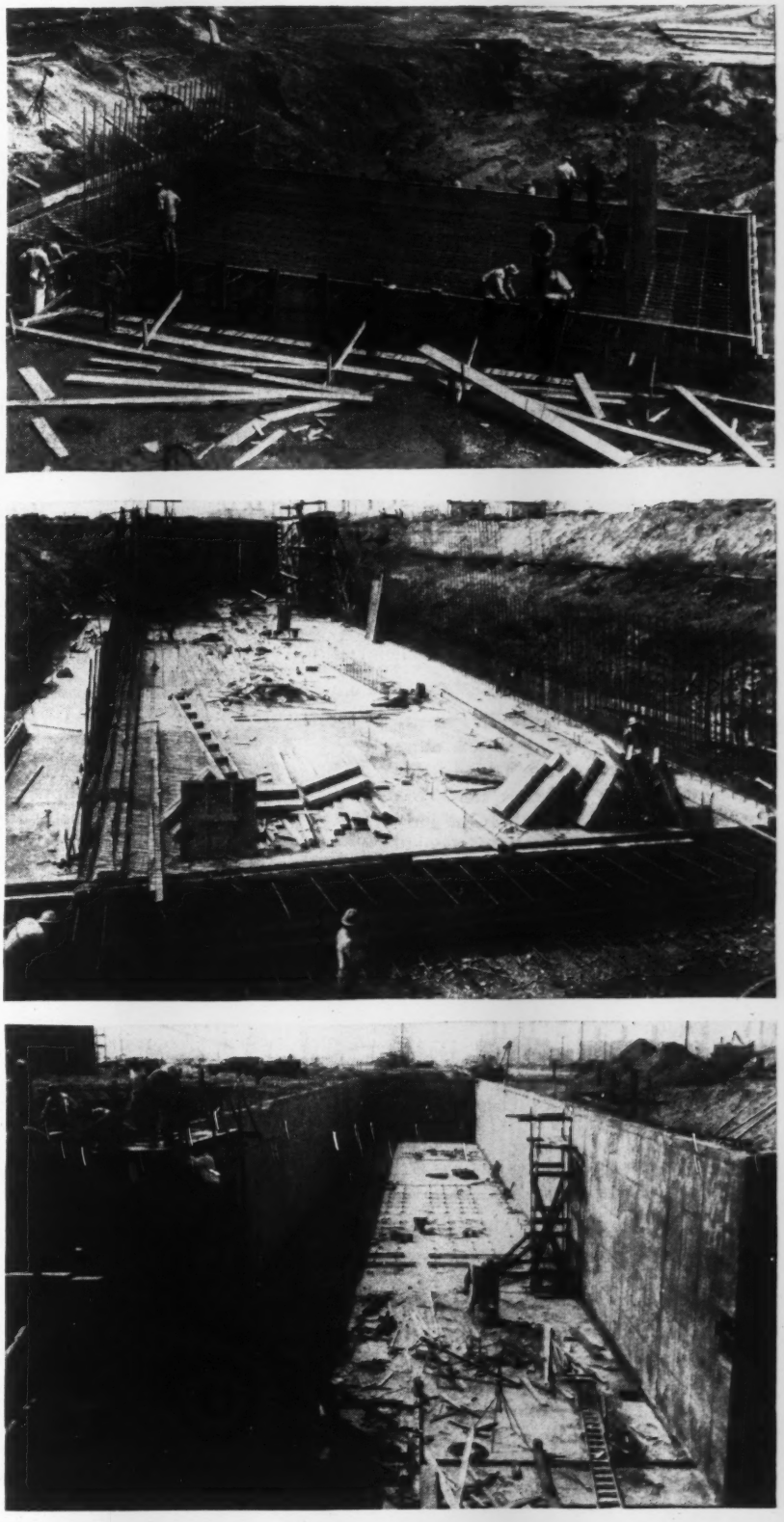

Fig. 2. Three steps in the construction of the hull dock are shown. Wellpoints on 4-ft. centers were used to keep the work in the dry. The plane was in the dock 15 days after the bottom picture was taken.

frame. These forms could easily be stripped and moved. Construction routine alternated daily between pouring a section and setting forms.

The dock was constructed over a 4-month period. The closeness of the construction schedule is demonstrated by the fact that the essential features were completed on the very day the plane moved into the dock.

Each of the wing float docks is 16 ft. wide and 50 ft. long. The distance from the center of each such dock to the center of the hull is 112 ft. These smaller docks have a bottom slab of 2-ft. thickness and walls 12 in. thick.

All of the dewatering facilities were placed in the hull dock. Corrugated pipe of 12-in. dia. is used for draining water from each of the wing float docks into the hull dock. Electrically driven pumps for dewatering the system have a total capacity of 5,000 gpm. and will empty the dock in 3 hr. and 10 min.

The gate for the hull dock is made of steel and wood and is hinged at the bottom. It can be raised and lowered by two electric hoists. Gates for the wing float docks are made of wood and are hinged at the side and opened and closed manually.

As a further protection for the ship, two finger piers or jetties, some 110 ft. long and 74 ft. apart at their tips, were constructed. When the ship is to be launched or docked, tractors will be attached to the plane on each side and the ship will be pulled along much the same as ships are towed through the Panama Canal. These jetties will be equipped with rubber bumpers.

Supports for the plane

As accurate alignment of the wings was required when mounting them on the hull, permanent type construction was followed in building frameworks to support the large and heavy wings during final assembly. One of these frameworks was located between each wing float dock and the hull dock. Part of each support was installed before backfilling the hull-dock excavation and was supported by the cantilever overhang of the bottom slab of that dock. The remaining section of each framework was carried on piling 20 ft. long.

The hull of the ship was built on a heavy cradle made of steel framework. This same cradle was used to support the hull when it was hauled from Culver City to the drydock and it will be used permanently to support the ship when it is in the dock. For permanent use, the cradle will be cut in two along its centerline so that each half can be slid aside.

To level the ship when it was placed in the dock, the cradle was set on a series of bolts equipped with screws. By use of these screws the ship was leveled in the fast time of two days.

When water is admitted to the dock, the bow of the ship will rise first. As it does, the weight of the plane which is normally distributed over the entire cradle will rest on the after-portion of the hull. To prevent such concentrated loads and the accompanying danger of crushing the hull, compensating supports are being installed. Each of these supports consists of two pneumatic cylinders attached to a beam extending under the keel. Four sets of such cylinders will be installed for the aft of the ship and one set forward.

The docking facilities were designed under the direction of John Stearns, plant engineer, Hughes Aircraft Co. Construction work was performed by the Guy F. Atkinson Co.

Slipperiness of Walk Surfaces Tested by Impact-Type Instrument

A joint research project has been undertaken by the National Safety Council and the National Bureau of Standards to develop safety codes for walkways and footwear. NSC is engaged in collecting data regarding accidents due to falling on slippery walks and NBS is developing methods for measuring the slipperiness of walkway surfaces.

It is extremely difficult to reproduce artificially, in the laboratory, walkway surfaces that are typical of the various conditions in service, because the location of a floor determines to a large extent the texture of its worn surface. Accordingly, P. A. Sigler of the National Bureau of Standards has designed a portable impact-type slipperiness tester that can be used to test floors in actual service. The design is based on the premises that slipping is a function of two surfaces and that in the process of ordinary walking slipping is most likely to occur when the walkway surface is first contacted by the rear edge of the heel.

The antislip coefficients obtained by this method are considered as relative rather than absolute values. Some of the results obtained, however, are of interest.

The antislip coefficients for concrete blocks ground with carborundum prior to testing ranged from 0.37 to 0.65, whereas the coefficients for a concrete floor with a cement-mortar topping, worn smooth over 25 years of service, ranged from 0.19 to 0.52. These results demonstrate the importance of surface condition and the inadvisability of assigning a single coefficient or even a single range of coefficients to one type of flooring.

The most important differences were observed in the wet state. Rubber tile with a very smooth molded surface showed high coefficients when dry but very low when wet. A rubber tile containing alundum grit was quite similar under dry conditions but was less slippery when wet. A rubber and cotton-fiber matting in service in a transit bus showed fair antislip characteristics under all of the test conditions.

Higher antislip coefficients were obtained for waxed asphalt tiles than for untreated tiles when tested with a rubber heel under dry conditions. With a leather heel the opposite was found true except for one type of wax. Under wet conditions, all of the corridors would be classed as potentially hazardous for both rubber and leather footwear and especially so when waxed. In general, the antislip properties of the waxed asphalt-tile corridors improved with continued exposure to dry maintenance and normal traffic.

Good antislip properties under wet conditions are usually associated with asperities that project through the film of water and thus prevent its action as a lubricant.

Putting Soils Knowledge To Work On Airfield Runways

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Contents in Brief—*In a study of the adequacy of the runways at Philadelphia's two airports, California bearing ratios were determined and plate load tests were made on both pavement and subgrade. These were related to rolling load tests made elsewhere by the Army Engineers. A basis for recommending changes in thickness of pavements and subgrades was thus developed.*

WITH THE DESIGN of new airfield runways or the evaluation of existing ones, the engineer is brought face to face with the desirability of combining practical procedures with the principles of soil mechanics. One of these instances occurred recently when our firm was asked by the city of Philadelphia for an evaluation of its two fields in relation to loads and traffic, both present and future.

The resulting investigation had two objectives: First, to determine the maximum safe gross plane weights that can be operated on the present runways. Second, to design the reinforcement or reconstruction required to operate with gross plane weights up to 300,000 lb.

Of the two Philadelphia fields involved, the Northeast Field is built on reasonably good soil—a sandy loam. It was, moreover, built under Army Engineer supervision and so benefited from a certain amount of scientific grading and compaction during construction. The Southwest Field (Hog Island tract), in contrast, is a hydraulic fills on top of clay-mud flats, and is representative of a large number of fields built for economic reasons on swampy foundations.

The problem here presented was the choice of tests that could be translated into definite conclusions. The science of soil mechanics has been under fire by practicing engineers because there seems to be so tenuous a relation between the results of soil tests such as density, shearing strength, sieve analysis, time consolidation, etc., and the selection, let us say, of a definite bearing value for a paved runway or of a foundation.

The purpose of this article is to make a frank disclosure of the processes by which the conclusions were arrived at, and to explain why a test was made and whether or not it entered into the final results.

Evaluating pavement capacity

It was decided to attempt to evaluate the pavements on the basis of several different methods or tests, which could be used to check one another. These were as follows:

1. California bearing ratio (CBR) tests.
2. Plate load tests on pavement.
3. Plate load tests on subgrade.
4. Observation of the behavior of the runways under their present loading.
5. Correlation studies based on certain parallel Army tests of California bearing ratios (CBR) versus rolling load and plate load tests.

The above methods were supported by other tests, including those for field density, moist, dry and maximum density, moisture content, Atterberg limits and clay content. In addition, quick shear tests and sieve analyses were run, and a number of hand auger borings made for soil classification purposes. The borings also were used to divide the runways into certain typical areas (Fig. 1) for the purpose of making general conclusions as to load capacities and to indicate the strategic locations for load tests and CBR tests. For instance, a hole showing a high clay content would indicate a different capacity from one showing no clay. In the same way, a change in the relative densities would indicate the desirability of additional CBR and/or plate load tests.

Some 300 borings were made with

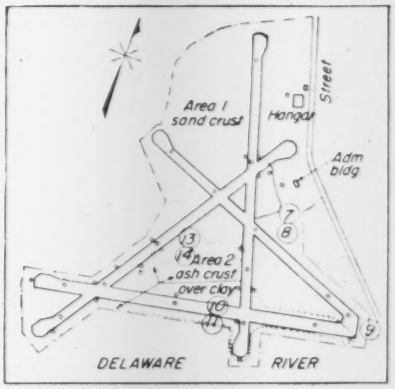

Fig. 1. Plan of Southwest Field, Philadelphia, showing division into ash crust on clay and sand crust areas. Small circles indicate location of hand auger borings and numbers locate loading tests charted in Fig. 5.

Fig. 2. Making California bearing ratio tests. Jack reaction provided by a loaded truck.

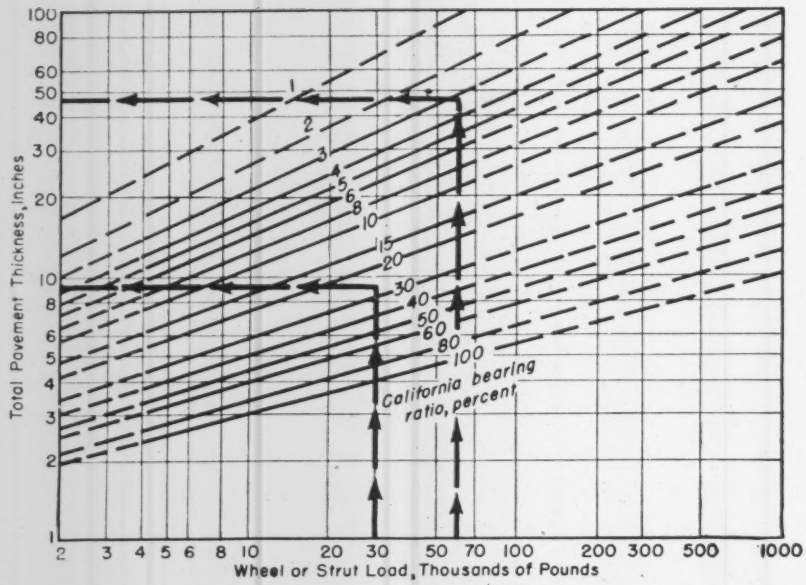

Fig. 3. Relation of pavement thickness to California bearing ratios for various airplane wheel loads. Problems worked out by arrows are those whose answers are shown in brackets in Table I.

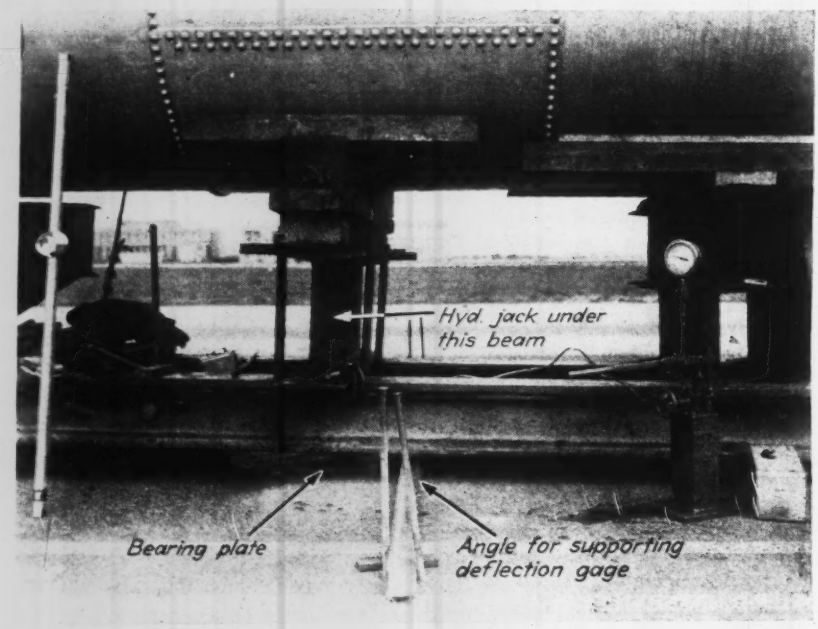

Fig. 4. Apparatus used for making plate load tests included a 30-in. dia. plate, hydraulic jack and a trailer loaded with a water-filled tank to furnish the necessary reaction.

6-in. hand augers or well diggers to a depth of 6 to 10 ft. Inspection of the soil from these borings was recorded and samples taken at any change of material. These samples were analyzed and classification of the soil types tabulated.

Deep borings were also made for the general purpose of determining the types of underlying strata and their depths. A well drill rig was used and samples were taken by split spoon.

Bearing ratio tests

The CBR tests were run in place on each type of subgrade directly beneath the pavement and, in addition, on the various types of soil outside the runways and at varying depths. The equipment used (Fig. 2) facilitated the work so that an average of six CBR tests were made daily.

The California bearing ratio (CBR) is a measure of the resistance of a soil to penetration of a 3-sq. in. piston, expressed as a ratio or percentage of the resistance of a standard crushed stone to penetration of the same piston. For example, a CBR of 50 means that a soil has one-half the resistance of the standard stone. These resistances have been further correlated so as to obtain a measure of the capacity of the soil in question to support applied loads, such as wheel loads.

The CBR may be obtained from a laboratory test by taking samples in the field, remolding them under standard conditions and testing the remolded sample. It has, however, been found, at least in the author's opinion, more practical and more reliable to make these tests on the soil in place in the field.

The typical form for reporting the test is as follows:

Penetration (in.)	Lb./sq. in. From Observation	CBR %	Lb./sq. in. Standard
0.10	233	23.3	1,000
0.20	367	24.5	1,500

In order to conduct this test conveniently, as shown in Fig. 2, a jack with pressure gage and an Ames dial deflection gage were rigged at the rear of a small truck, which when loaded with sand bags furnished the reaction for the jack. A CBR could thus be obtained at any location and at any level desired by excavating to that depth. In order to avoid error, three tests were run at each location, about a foot apart.

To determine the adequacy of the present runways the graph in Fig. 3 was used. Inasmuch as the desired strut load and the CBR were known, the diagram gave the required pavement or crust thickness.

The effect of dual wheels must also usually be taken into account. These wheels are usually far enough apart—some 4 ft.—so that in investigating pavements, one wheel load or one-half the strut load may be used, but in investigating the subgrade, where the pressures from each wheel will conflict, something more than the single

wheel load is necessary. Actually, this factor varies according to the depth of the stratum being investigated. Army tests show, for instance, that the factor varies from 1 for a 10-in. pavement and base to 2 for a 75-in. pavement and base such as would be needed for B-29 loading.

Plate load tests

Plate load tests were made on both the pavement and on the subgrade, with equipment (Fig. 4) that permitted loads up to 100 tons to be applied on one plate, usually of 30-in. diameter. The equipment, as shown in the bottom view of Fig. 4, was accurately centered so that the entire load of filled tank and trailer could be balanced on the hydraulic jack under the I-beam. Two Ames deflection gages were clamped to an angle, and these gages set on the bearing plate, one on either side of the jack. The angle was supported by steel blocks at least 8 ft. from the center of the bearing plate.

Loads were applied in increments of 10,000 lb., and the deflection for each load was recorded periodically until no further deflection occurred in 5 min. The loading was increased sufficiently to cause failure, indicated by cracking of the pavement or subgrade and by accelerated settlement under a constant load maintained on the jack with the hydraulic pump. The mobility of the equipment used in these tests reduced materially the time required in moving and setting up for another test.

A 12-in. diameter plate load test also was made to furnish possible data for interpolating or extrapolating other plate sizes. The reason for using other plate sizes would be, of course, that the plate is supposed to have the same area as the contact area of the tire, which varies with the wheel load.

Plate load tests, typical results of

TABLE I—SUMMARY OF RESULTS—SOUTHWEST AIRPORT—AREA I, SAND CRUST

EXISTING CONDITIONS
2½ in. Asphalt Concrete
5 in. Gravel Base C.B.R. 80
64½ in. Sand Crust C.B.R. 25
72 in. Total
Muck C.B.R. 3

THICKNESS REQUIRED — INCHES
(Col. a) Pavement and Base.
(Col. b) Crust, Base and Pavement.

		60,000 (Strut Load)		100,000 (Strut Load)		150,000 (Strut Load)	
		(a)	(b)	(a)	(b)	(a)	(b)
1. Plate Load Test	Ultimate load (See Test 7, Fig. 5) = 120,000 lb. Using a safety factor of 2 gives a safe single wheel load of $\frac{120,000}{2}$ = 60,000 = wheel load.						
	† Safe strut load on pavement (for dual wheels) equals 60,000 ÷ ½ = 120,000.	<7½	72	<7½	>72	>7½	>72
	† Safe strut load on crust = 60,000 ÷ 1 = 60,000						
2. By C.B.R. (Fig. 3)	For pavement with single wheel load = ½ strut load;	9½	...	11	...	13	...
	For crust, use strut load	...	46	...	60	...	72
3. Gray's Formula	At 0.25 in. deflection the load carried was 22,000 lb. (See Load Test 8, Fig. 5) P = 22,000 ÷ 707 = 31 p.s.i.	7	...	9	...	12	...
4. Gray's Formula	(See Load Test 7, Fig. 5). Using ½ ultimate load taken on top of pavement, P = 60,000 ÷ 22.5²π = 38 p.s.i.*	5	...	7	...	9	...
5. Operating Load	45,000 without failing in clay area. By comparison of relative strengths this area approximately 1.5 as strong as clay areas.	7½	...	7½	...	7½	...
		Increase Pavement and Crust to					
6. Recommendations from above results		7½	72	10½	OK	14½	OK

† Relation of wheel loads to strut loads at various depths.
For 10 in. Crust factor = ½
For 35 in. Crust factor = 0.7
For 72 in. Crust factor = 1
* Sketch at right shows derivation of 22.5.

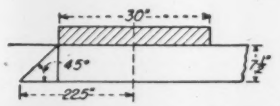

TABLE II—SUMMARY OF RESULTS—SOUTHWEST AIRPORT—AREA II, ASH CRUST

EXISTING CONDITIONS
2½ in. Asphalt Concrete
5 in. Gravel Base C.B.R. 80
26½ in. Ash Crust C.B.R. 25
36 in. Total
Muck C.B.R. 3

THICKNESS REQUIRED — INCHES
(Col. a) Pavement and Base.
(Col. b) Crust, Base and Pavement.

		60,000 (Strut Load)		100,000 (Strut Load)		150,000 (Strut Load)	
		(a)	(b)	(a)	(b)	(a)	(b)
1. Plate Load Test	Ultimate load (See Test 10, Fig. 5) = 70,000 lb. Using a safety factor of 2 gives a safe single wheel load of $\frac{70,000}{2}$ = 35,000 = wheel load						
	† Safe strut load on pavement (for dual wheels) equals 35,000 ÷ ½ = 70,000.						
	† Safe strut load on crust = 35,000 ÷ 0.7 = 50,000	<7½	>36	>7½	>36	>7½	>36
2. By C.B.R. (Fig. 3)	For pavement with single wheel load = ½ strut load;	9½		11		13	
	For crust use 0.7 strut load		40		50		61
3. Gray's Formula	At 0.25 in. deflection the load carried was 22,000 lb. (See Load Test 11, Fig. 5). P = 22,000 ÷ 707 = 31 p.s.i.	7	...	9	...	12	...
4. Gray's Formula	(See Load Test 10, Fig. 5) Using ½ ultimate load taken on top of pavement P = 35,000 ÷ 22.5²π = 22 p.s.i.	10	...	13	...	18	...
5. Operating Load	45,000 without failure	>7½	...	>7½	...	>7½	...
		Increase Pavement and Crust to					
6. Recommendations from above results		7½	50	11	60	13	72

† See footnote to table above

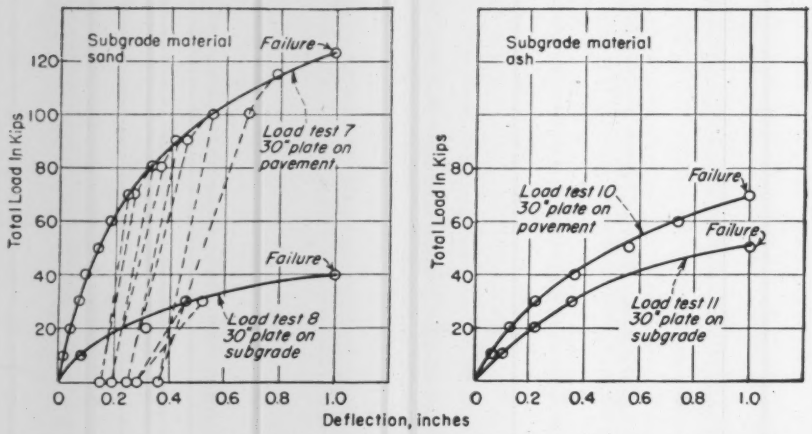

Fig. 5. Results of various plate load tests for both pavement and subgrade, relating deflections to load.

which are shown in Fig. 5, were used in four ways to determine safe carrying capacity:

1. Safe load was computed as an arbitrary percentage of the ultimate.

2. The psi. for Gray's formula was computed from the load at 0.25-in. deflection as giving a conservative limit, because a large proportion of the deflection was considered to be compaction. (Grays formula is $t = 0.564\sqrt{\frac{W}{p}} - r$, where t is thickness of pavement and base, W is plane wheel load, p is allowable psi. on subgrade and $r = \sqrt{\frac{A}{\pi}}$ in which A is the wheel load divided by the tire pressure. In this study, tire pressures of 80, 85 and 90 psi. were used for 30,000, 50,000 and 75,000 lb. wheel loads respectively.)

3. The psi. for Gray's formula was computed from one-half the ultimate strength.

4. The modulus of subgrade reaction (to be used in rigid pavement design) was computed as the ratio of psi. to deflection, where deflection = 0.05 in.

The question concerning the deflections to which a flexible pavement may be subjected without injury has not been satisfactorily answered. The Asphalt Institute recommends 0.50 in. deflection on the basis of its recently improved testing methods.

The Army, as a result of extensive tests suggests 0.05 in. for a 10-in. base and pavement and 0.24 in. for a 50-in. base and pavement, deflections to vary in accordance with depth of base.

Recommendations

Tables I and II present the results obtained by the various approaches, compared with recommendations made. These recommendations for dual wheel strut loads, translated into their application to the Southwest Airport, were as follows:

Area 1 is satisfactory for planes up to 60,000 lb. strut load, both as to fill and as to pavement.

For a 100,000 lb. strut load, add 3 in. of bituminous pavement; subgrade is satisfactory.

For a 150,000 lb. strut load, add 7 in. of bituminous pavement; subgrade is satisfactory.

In Area 2 the 7½ in. pavement is satisfactory, but a 50-in. subgrade with a CBR of 25 or better is required for a 60,000 lb. strut load.

For a 100,000-lb. strut load pavement thicknesses should be increased with 3½ in. of bituminous concrete, and the subgrade should be at least 60 in. deep with a CBR of 25.

For a 150,000-lb. strut load, the pavement should be increased with 5½ in. of bituminous concrete while the subgrade should have a thickness of 72 in., with a CBR of 25.

The recommended subgrade increases will probably require the excavation and replacement of the present ash crust with a compacted material. If this new subgrade has an adequate CBR coefficient, the recommendations for added pavement thickness may be reduced somewhat.

Correlation studies

It is to be noted that there were no actual full-size wheel-load tests made on the Philadelphia airports, other than those provided by the lighter planes, up to 50,000 lb. strut loads, which have been landing on these fields. Since full-size wheel-load tests are "the proof of the pudding", it was desired to check the conclusions shown in Table I and II with the results of such tests. Recourse, therefore, was had to a series of Army tests comparing full-size rolling load, CBR and plate-load results, from which a correlation study could be made to predict, in a rough sort of way, how closely CBR and plate tests forecast what the rolling load tests would show.

While these Army tests (Table III) contain many discrepancies and cover special conditions, particularly at the Stockton Airbase in California where a double pavement was involved, they indicate a reasonable agreement between the CBR and rolling-load tests and also a fairly good agreement with Gray's formula if an 0.05 to 0.1 in. deflection is assumed as a proper point for computing the psi.

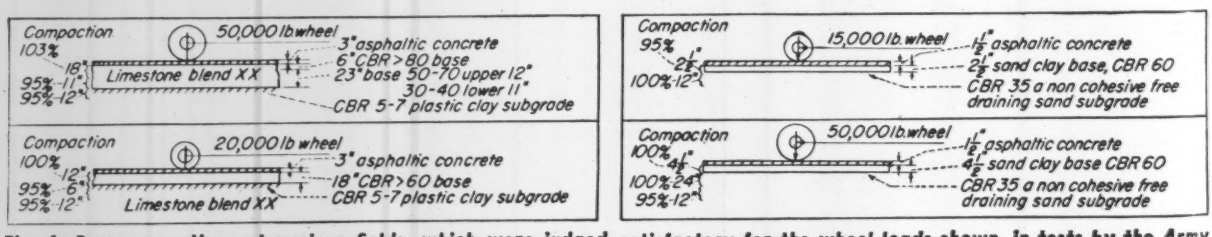

Fig. 6. Runway sections at various fields, which were judged satisfactory for the wheel loads shown, in tests by the Army Engineers. The limestone-blend base under two of the runways is a mixture of sand and crushed stone.

TABLE III—ROLLING LOAD, PLATE LOAD AND CBR TESTS AT ARMY AIRFIELDS
Correlation Study By Author

Required Thicknesses in Inches of Pavement and Base

Type of Test	Barksdale Field Type I Base [1]		Barksdale Field Type II Base [2]		Langley Field [3] & [5]		Elgin Field [4]		Stockton Field [5] & [9]	
Single Wheel Load in Kips.	50	20	50	20	50	20	50	15	40	25
By CBR at top of subgrade.	31	21	31	21	15	11	9	6	40	32
Rolling Load [6]	30	17	27	17	21	<12	6	<4	18	18
Plate Load [7] def. = .05"	29	16	29	16	30	17	11	6	38	28
" " def. = .10"	16	8	16	8	17	13	5	2	23	16
" " def. = .15"	12	6	12	6	12	7	2	0	17	12
" " def. = .20"	10	5	10	5	9	5	0	0	13	9

(1) Subgrade: Plastic clay, CBR 5 ..... Base: Limestone, loam, sand and clay ..... Pavement: 3-in. asph. conc.
(2) Subgrade: Plastic clay, CBR 5 ..... Base: Crushed limestone blend ..... Pavement: 3 in. asph. conc.
(3) Subgrade: Fine sand, hyd. fill, CBR 15 ..... Base: Crushed stone macadam ..... Pavement: 3 in. asph. conc.
(4) Subgrade: Free drainage sand, CBR 35 ..... Base: Sand and clay ..... Pavement: 3 in. asph. conc.
(5) Subgrade: Abode clay, CBR 3 ..... Base: Gravel ..... Pavement: 3 in. asph. conc.
(6) Based on a minimum number of coverages selected as satisfactory by author: 500.
(7) By Gray's formula using p.s.i. causing above-given deflections.
(8) CBR values were probably lowered during tests due to water; tends to vitiate results.
(9) Base was on top of old pavement; tends to vitiate results.

The government tests indicate that the density of traffic has a large influence on the capacity of a runway to stand up. In non-homogenous soil particular weak spots may occur, and to detect them the airport authorities should either have a rolling-load apparatus or depend upon maintenance conditions to give warning of an actual break-through.

Some of the conclusions reached by the Army Engineers in regard to the strength and use for flexible pavements are given in Fig. 6. They are given to enhance an engineer's "experience perspective", and should not be used for design criteria. From them, however, and from the data in Table III, certain useful generalizations can be made:

Economy may be obtained within certain limits by knowing that a layer-cake subgrade consisting of a high CBR at the top layer and lower CBRs in the lower layers is just as effective as a single layer of high CBR of the same total thickness.

The base of a runway should be compacted with machinery which will have at least the same compacting effect as the heaviest plane load expected to be used. This means, in effect, rubber tires loaded to the same load as the plane load.

Where water is trapped by impervious lenses in a granular soil, a condition occurs which produces a weakness in the pavement.

In designing taxiways, aprons and that portion of the runway where planes are likely to stand, a 25 percent increase in wheel loads should be used.

Tests by the Army indicate that the stress at the contact point caused by impact of landing is no greater than the stress caused by equivalent static load. (Ref. see "Concrete Pavements in Different Subgrades". Ohio River Diversion Laboratories, Mariemont, Ohio. Jan. 1946.)

The thicknesses required will vary in accordance with the density of the traffic. In this connection, excessive maintenance would indicate too thin a pavement. Of course, sudden failures (by which is meant a wheel breaking through the pavement) can occur from a frost heave or from a local condition where the subbase was weak and the pavement thin, or from the trapping of water near the surface, as mentioned above.

While the Army conclusions indicate that the allowable subgrade deflection, which should be used for determining the psi., should vary with the thickness of pavement and base, the correlation studies do not bear this out.

Excessive clay in a sand-clay base will tend under wheel pressures, to produce free water and weakness under rolling loads. In the Army test where this was observed, the clay percentage was 15 percent the liquid limit 22, plastic limit 17, over a clay subgrade of CBR of 5.

The Philadelphia tests were conducted under the supervision of Thomas Buckley, director, and Samuel S. Baxter, projects engineer, of the Philadelphia Department of Public Works.

The tests were formulated by Elwyn E. Seelye & Co. under the general direction of Burnside R. Value, executive engineer, and carried out under the direct supervision of Williams D. Bailey.

I wish to acknowledge the assistance rendered me in the preparation of these tests by Gayle McFadden, Chief Airfields Branch, Engineering Division, War Department, Washington, D. C.

Anti road tax diversion efforts make progress

Resolutions proposing constitutional amendments to require that highway user tax revenues shall be used only for highway purposes have been introduced in the legislatures of Arkansas, Connecticut, Delaware, Indiana, Massachusetts, New Mexico, Rhode Island, Tennessee and Utah.

In Indiana, Massachusetts and Tennessee, the proposed anti-diversion amendments were passed by the 1945 legislatures and if again passed in 1947 will be submitted to the voters. The Tennessee amendment has passed the senate with only one dissenting vote.

Nineteen states, (California, Colorado, Idaho, Iowa, Kansas, Kentucky, Maine, Michigan, Minnesota, Missouri, Nevada, New Hampshire, North Dakota, Oregon, Pennsylvania, South Dakota, Texas, Washington and West Virginia), at present have constitutional amendments protecting the integrity of highway funds. Thus, if all the amendments proposed this year are adopted it will make a total of 28 states protecting highway user taxes against diversion.

Pressure Under Cylindrical Stack Computed by Trial and Error

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***Contents in Brief**—When the wind pressure on a high steel stack causes the resultant of the loads to fall outside the middle third of the base, a trial-and-error method can be used to determine the bearing stresses. The effective base area is assumed, stresses due to wind and dead load computed and the original assumption corrected, if necessary.*

In modern power stations, with high steel stacks supported upon the building frame, it is important that a reasonably accurate investigation be made of the resultant loading on the base. This article sets out a simple method of obtaining the position of the neutral axis and thereby the bearing pressures at the base of cylindrical stacks.

Obviously, no difficulty arises if the resultant of the wind and dead loads falls within the middle third of the base, as the whole of the area in contact between the stack and the supporting beams is effective. The maximum and minimum bearing stresses under this condition can be calculated thus:

$$\frac{\text{Dead Load}}{\text{Contact Area}} \pm \frac{\text{Wind Moment}}{\text{Contact Section Modulus}}$$

However, the relatively light weight of steel stacks, even though brick-lined, combined with normal wind pressures, usually brings the resultant outside the middle third, and this is the type of problem requiring special analysis.

The effective area of the base of the stack on the steel supporting beams generally takes a form somewhat as shown in Fig. 1, with tension in the windward bolts. Due to the axial load, considerable compression exists below the neutral axis of the effective base area, which varies with different proportions of wind and dead loads. The main problem is to compute this effective area.

A convenient method is to assume an effective base area, then calculate the center of gravity and moment of inertia. The stress at point X (Fig. 1) due to direct compression and bending may now be found. If this stress is zero, the correct area was assumed. Otherwise, by trial and error an area must be found such that the combined stress at X is zero.

As an example, consider a steel stack 14 ft. in diameter, flared out to 22 ft. at the base, 184 ft. high, supported on steel beams as shown in Fig. 1, and secured by 8 pairs of bolts. The weight of the steel stack and [illegible]ing is 447 kips, and the wind m[illegible]ent is 3,381 ft.-kips. The resulta[illegible]t the base is outside the middle t[illegible]d, and therefore there must be tensi[illegible] in the windward bolts.

As a first assumption, take [illegible] effective compression area as 50 p[illegible]ent of the base area, or 5,500 sq. i[illegible] (Fig. 2). The tensile area is 6x3.7[illegible] or 22 sq. in. By means of a ca[illegible]board model, the center of gravity is found to be 7.08 ft., or 85 in., fr[illegible]m the center line of the stack, and the moment of inertia of the assumed effective area is computed to be 10,541,000. The stack moment about the neutral axis is $3,381 - 447 \times 7.08 = 211.5$ ft.-kips. Thus, the combined stress at X is

$$\frac{447}{5,500} - \frac{211.5 \times 12 \times 85}{10,541,000} = 0.0605$$

indicating that the assumed area is too small, since compression still is present.

As a second trial, take the effective compression area shown in Fig. 3, 7,100 sq. in., with tensile area 22 sq. in., center of gravity 120 in. from X and moment of inertia 24,069,000. The stack moment about the neutral axis is $3,381 - 447 \times 5.2 = 1,061$ ft.-kips. In this case, the combined stress at X is

$$\frac{447}{7,100} - \frac{1,061 \times 12 \times 120}{24,069,000}$$

is negligible, and the assumed effective area is very close to the true condition. By means of this area, the pressure at various parts of the base can be calculated in the same manner as for X.

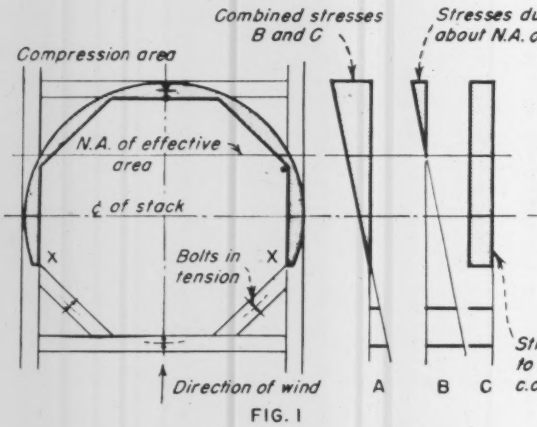


FIG. 1

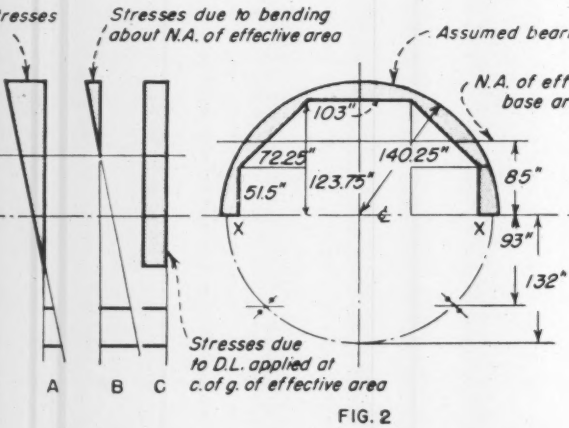


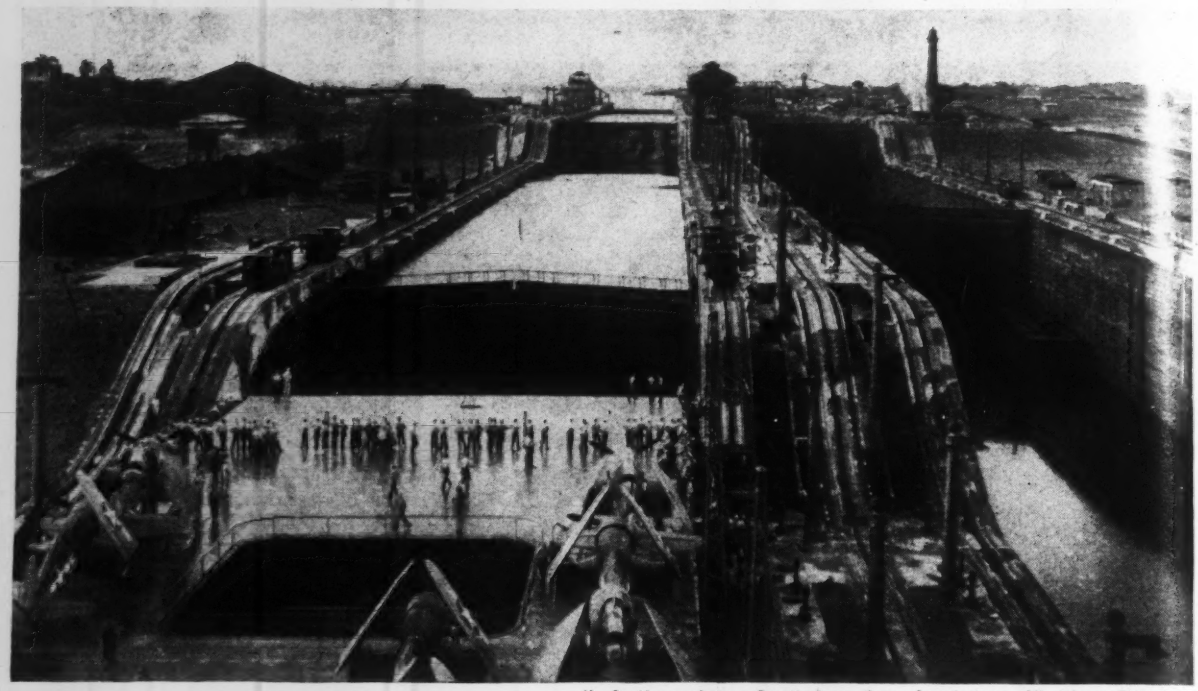
FIG. 2

FIG. 3

The effective compression area at the base of a stack when the resultant is outside the middle third is less than the base contact area. Trial and error is used to solve a sample problem, first assuming half the area as effective (Fig. 2) and then the condition in Fig. 3. When the stress at X is zero, the correct area was assumed.

Fitting the Canal to an A-Bomb Age

Contents in Brief — Whether to supplement, convert to sea level or improve the Panama Canal is the subject of exhaustive engineering studies being carried out by the Governor of the Canal Zone under a mandate from Congress requesting a recommendation for the best solution as measured by ample capacity and wartime security. A total of 22 routes from Mexico to Colombia has been investigated. Sea-level canals have received major attention, as have a lock canal at Nicaragua and an improved arrangement of locks in the Panama Canal. A recommendation will be made to Congress before the end of the year. Regardless of what it is, a big engineering and construction job — perhaps the biggest ever conceived — is involved.



U. S. Navy photo. Frontispiece, Press Association. All others, ENR Staff

Fig. 1. Locks in the Panama Canal, such as those at Gatun, whose future adequacy and wartime safety are in question.

Puzzle in Panama

Waldo G. Bowman
Editor, Engineering News-Record

A good many things came to an end when the atomic bombs exploded over Hiroshima and Nagasaki. And not the least of those things that were lost forever was our confidence in the security of the Panama Canal.

That fact is now being reflected in a comprehensive engineering study to determine whether the present canal or any canal in the same or any other location can be made safe for our merchant and naval fleets in wartime. And, of equal concern, if not of the same grimness in consequences, is the problem of the adequacy of the canal to meet the growing demands of peacetime shipping. It all adds up to a puzzle of first order magnitude.

Nor is the puzzle simplified (although the scope for its solution is undoubtedly broadened) by the fact that the atomic bombs not only blasted confidence in the present canal, but also raised up a ghost—that of a Panama sea-level canal whose earthly body was interred on June 29, 1906, when Congress adopted the lock type canal favored in the minority report of President Theodore Roosevelt's board of consulting engineers. And to this sea-level canal ghost the present investigators may well repeat Hamlet's famous questions to the ghost of his father, "Be thou a spirit of health, or goblin damned? Say, why is this? Wherefore? What should we do?" Sea level or not, and if not, then what? That is the question, and the present puzzle in Panama.

Because a proper solution is of vital importance to every American, and of major interest to all engineers and construction men, a first-hand account of the progress of the studies was deemed timely and desirable. What the conclusions and recommendations will be is not now known, indeed will not be known until they are reported to Congress late this year. But after two weeks in the Canal Zone talking to officials, witnessing tests, traveling the canal, clambering over its famous once-sliding banks, inspecting its locks and dams, and listening to scuttlebutt and rumor, a reasonably complete account of "Isthmian Canal Studies—1947" can be rendered. This is it.

Objective and plan of their studies

The studies had their beginning on Dec. 28, 1945, when Public Law 280, 79th Congress, 1st Session was passed. In it Congress said to the Governor of the Panama Canal, "Tell us how we and the American people can best be assured of a ship crossing of the isthmus that will be safe from war hazards and of ample capacity for many years to come. Give us a recommendation for the best type of canal and the best route, no matter where located, in Panama or out."

Included in the studies, of course, was to be a revaluation of the $277,000,000 project to build a third set of locks, larger and removed some distance from the present pair, begun in 1939 (*ENR* Sept. 14, 1939, vol. p. 330) and suspended because of the war in 1942 after most of the necessary excavation had been completed.

Maj. Gen. Joseph C. Mehaffey, Governor of the Canal Zone, and himself an Army Engineer officer with a long record of service on the canal, lost no time in initiating the authorized study, for which about $5 million has been provided. Assigning the task to the canal's Special Engineering Division, which was created to handle the Third Locks Project, he appointed Col. James H. Stratton as Supervising Engineer. Enjoying an outstanding reputation as one of the ablest technical men and administrators in the Corps of Engineers, Colonel Stratton was soon successful in assembling an unusually capable staff of civilian engineer specialists to head up the various phases of the work. Supplementing his own organization with a board of eminent consulting engineers to afford continual guidance and advice, he went to work. And as need developed, individual specialists from private life and from the Office of the Chief of Engineers were called in while, in addition, special research contracts were awarded so as to bring the nation's best talents to bear on the problem.

The procedure of the studies is simple and effective. Investigations of each particular subject—routes, lock design, dredging, drilling and blasting, soil mechanics, flood control, hydraulics, construction planning, to name a few—are carried out by the staff specialists through their own research and analysis and aided by the outside research contracts. As the study of each phase or subject is completed, a report or memorandum is prepared. Then, at the periodic meetings of the consulting board, the section heads present the memos (No. 183, having been reached on March 14), which are approved, turned down or returned for further study.

The eventual result of this whittling and sifting will be a set of conclusions from which a final recommendation can be made to the Governor by Colonel Stratton and the board. If the Governor accepts it, as is probable since he keeps in close touch with the work even to taking part in the consulting board meetings,

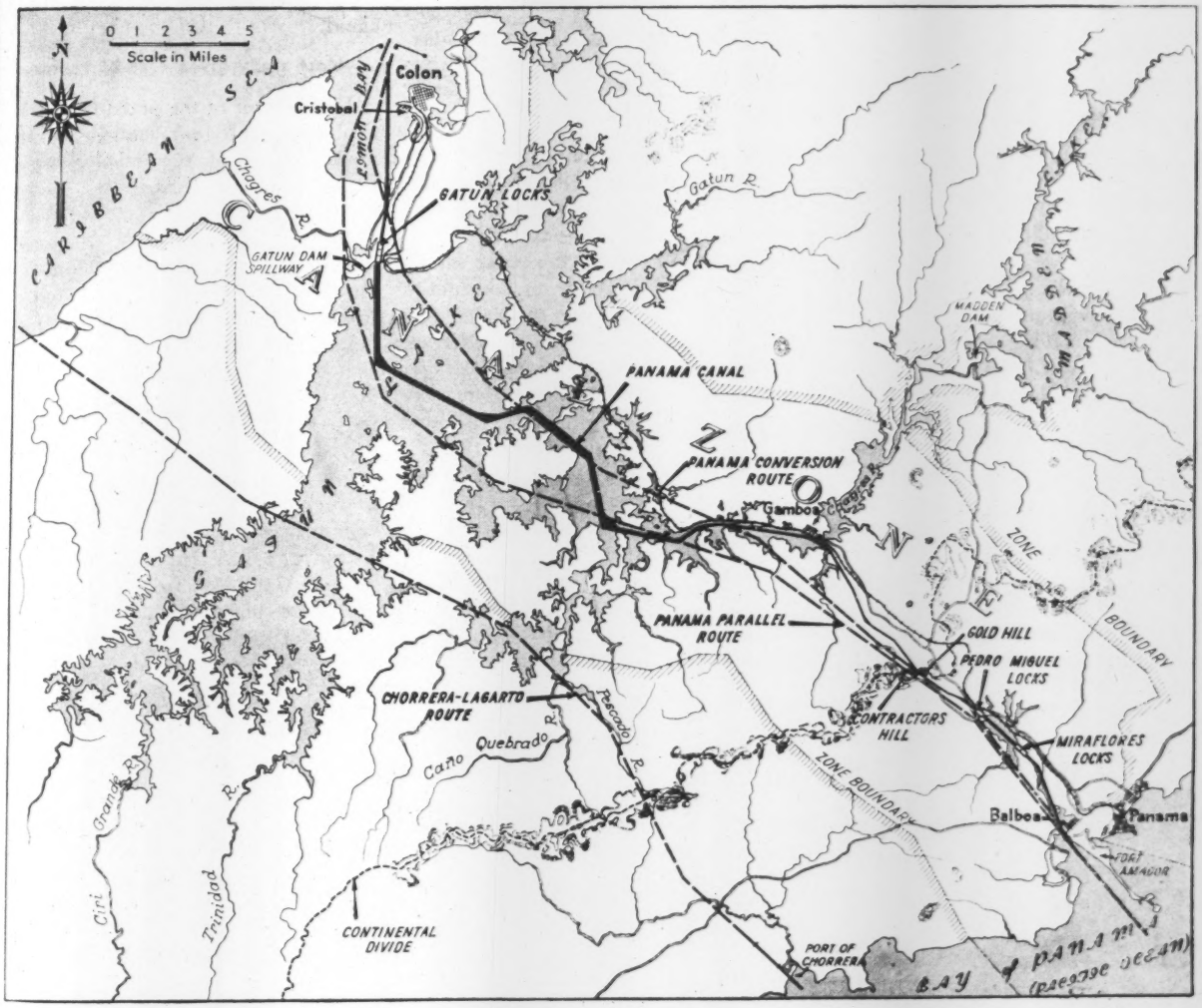


Fig. 2. The Panama Canal and three of the alternate routes in its near vicinity whose engineering feasibility and relative cost and security are under investigation.

Fig. 3. Engineering and construction studies initially encompassed 22 isthmian routes from Mexico to Colombia. Those named plus two others—the Panama Parallel and Panama Conversion Routes near the present canal — warranted the most study.

the recommendation will be presented to the War and Navy departments for review, and will then go to Congress. What happens after that in the way of actual design and construction is up to the law makers, the President and the American people.

Considering the study procedure and the topnotch technical talents of the men engaged on the work, and observing their earnestness of purpose and high sense of responsibility, one cannot but feel that the recommendation will be honestly arrived at, technically sound and unaffected by frivolous whims or superficial reasoning. There almost surely will be those who will disagree with the recommendation, but none except the carelessly biased or the unscrupulous who would question its integrity.

Since Congress ordered examination of all possible routes, the obvious line of attack was to study each possibility in turn to the point where it eliminated itself from consideration because of lack of water for lockages, too great length, poor terminals, excessive excavation, lack of security, and other applicable reasons. If followed thoroughly and fairly, this procedure should leave for final consideration the best type canal on the best route. To achieve a degree of comparison among all routes a hypothetical canal was initially assumed in each case, with a bottom width of 500 ft. and with side slopes of 1:1.

A total of 22 routes was examined, as shown on the map, Fig. 3. Including practically all of the routes that have been proposed or studied over the past century or more, the list contained some that were readily dropped from consideration as patently impractical, others that required more detailed study and a few upon which special field work was deemed necessary. Indicative of routes easily eliminated was Tehauntepec in Mexico, which has the advantage of being nearest the U. S., but would require 6½ billion yards of excavation for a sea-level canal and 15 lifts of about 39 ft. each for a lock canal. Another even more easily eliminated was Chiriqui in Panama near the Costa Rican border where an even greater yardage would have to be removed to create a sea-level canal and where there is no water at high elevation to supply a lock canal.

Most study given 4 of 22 routes

Elimination of the patently impractical routes left four, outside the immediate area of the existing canal, for further study—San Blas (named for an area and an Indian Tribe) and Caledonia Bay, for either a sea-level or a lock canal; Atrato-Truando (named for the two rivers that it follows) for a sea-level canal; and Nicaragua, (with Pacific terminus at Brito) for a lock canal. Except for Nicaragua, the available field data were less than desirable to permit a satisfactory analysis. Field surveys were, therefore, undertaken, using both ground and aerial mapping procedures. Such ultra-modern aids as two-way radio communication between ground and air, radar profiling from the planes, mapping cameras that take pictures at 1-sec. intervals and special ground altimeters pro-

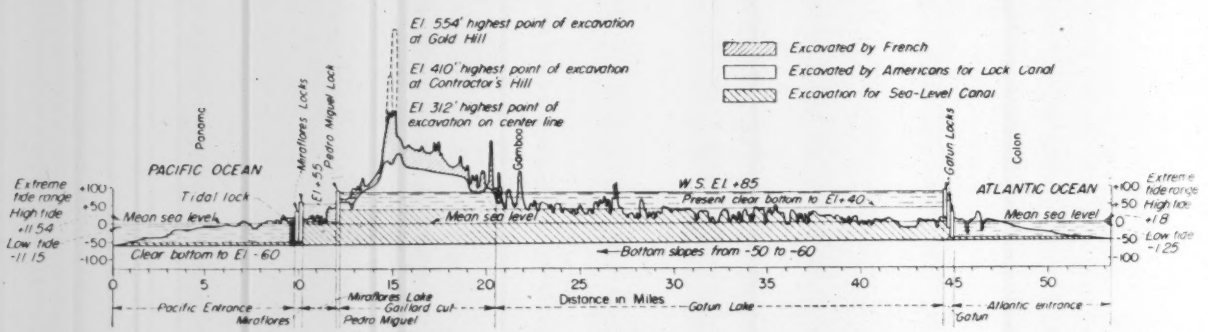


Fig. 4. Profile of Panama Canal indicates both present layout of locks and lakes and the excavation that would be required to convert it to a sea level canal with only a tide lock at the Pacific entrance.

vided much better data than were available before, so that the decisions that will be made as to these routes should be correspondingly better.

Whether San Blas, Caledonia Bay or Atrato-Trunado will be shown to have potentialities comparable to Nicaragua, whose merits have long been recognized, remains to be seen. However, a sea-level canal at Nicaragua is probably ruled out because the necessary draining of Lake Nicaragua would deprive the country of an important body of water and probably alter its climate. The lock canal, favorably reported on in 1931 by the late General Daniel Sultan, is still one of the best possibilities if a supplementary canal at another location than Panama is deemed necessary. Its cost now could easily be twice the $722 million estimated by General Sultan, and its safety from modern weapons of destruction would be no greater than that of the present canal, but such disadvantages are relative, and might, in a comparison with other routes, be worth accepting.

Improving the present canal

Obviously, any new route for a canal must be far superior to the present one to warrant serious consideration, unless, of course, we are to have two canals, a possibility that cannot be ruled out and one which it is understood has been considered in connection with some proposed routes near the present canal. These will be described later in this article, but first the proposals for improving the present canal need to be considered.

The existing Panama Canal has many advantages. It has operated successfully for over 30 years. Its length is comparatively short. Its total lock lift of 85 ft. is moderate. It has ample water supply. Its terminals are established communities with efficient harbor and port facilities. It represents one of our proudest national possessions, and is among one of our largest capital assets. What then does it lack?

First, its present capacity is estimated to be inadequate for commercial shipping after 1964, and its locks are not wide enough for modern and future naval vessels. (It was to overcome these disadvantages that the Third Locks Project was initiated, providing lock chambers 140 ft. wide as compared with the present 110 ft.) Second, it may not be safe against modern bombing. These were the items—capacity and security—on which Congress asked to be assured.

Insofar as capacity is concerned it is certain that the lockage load of the present canal can be increased. The Third Locks Project would do it. Replacement of the existing locks with new ones of larger dimensions and increased efficiency would also do it. Even the installation of a type of gate that could be removed for maintenance and repair (while a temporary gate replaced it) would

Fig. 5. Gaillard Cut whose slides have caused so much trouble would again be the scene of major construction if any scheme involving widening, deepening or straightening is recommended. Present knowledge, it is believed, could cope with the slide menace.

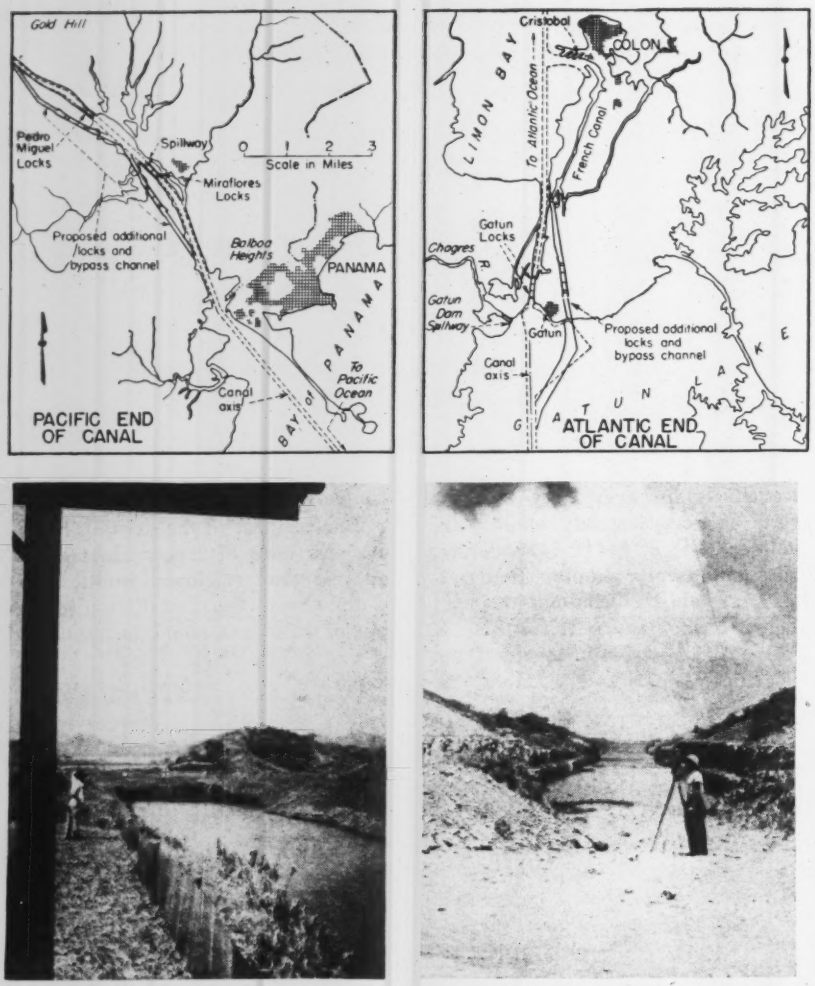


Fig. 6. Third Locks Project begun in 1939, whose questioned adequacy to increase capacity and security of the present canal brought about the present investigation. Maps indicate location of project relative to present locks while pictures show completed new lock cuts as they exist today; left, cut at Pacific end looking across plug that separates it from Miraflores Lake; right, cut at Atlantic end looking seaward from plug that separates it from Gatun Lake.

greatly increase capacity by reducing the present overhaul time that keeps one lane of the existing locks out of service 4 months every 2 years.

The present investigators, however, are believed to favor a fourth way as best meeting the needs of increased capacity and security for the present lock canal. This is by means of the so-called Pacific Terminal Lake Plan in which all lock lifts on the Pacific side would be concentrated in the vicinity of Miraflores; in effect this would eliminate the single lift lock at Pedro Miguel, and raise Miraflores Lake to El. 85 so that it would become an integral part of Gatun Lake, connected to it by Gaillard Cut.

To understand this plan, as well as ones proposed to convert the lock canal to one of sea level type, it is necessary to have the layout of the present 45-mile long canal clearly in mind. Briefly, it consists of a large artificial lake, called Gatun Lake, at El. 85 ft. above sea level, reached by three lock lifts on both the Atlantic and Pacific sides. Ships entering from the Atlantic side, for example, are raised in the Gatun Locks whose three lifting chambers, each 110 ft. wide and 1,000 ft. long, are continuous and in the same structure. They then traverse the lake for some 20 miles in a winding channel 500 to 1,000 ft. wide that follows the former valley of the Chagres River whose waters have been impounded to form the lake.

Leaving the lake, ships enter Gaillard Cut, 300 ft. wide at the bottom and 7 miles long, emerging to enter a single lift lock at Pedro Miguel, which drops them 30 ft. to Miraflores Lake at El. 55 ft. above sea level. Miraflores Lake is about a mile long, closed at its southern end by Miraflores Locks, a two-lift structure in which the ships are lowered to the level of the Pacific Ocean, which is 7 miles farther on. It will be recalled that the single lock lift at Pedro Miguel was separated from the twin lifts at Miraflores (instead of putting all three together as at Gatun) because of poor foundations at the north end of the Miraflores site. Some of the early canal engineers did not agree that the conditions were as "poor" as represented, and many concur in that view today.

Improving the lock layout

The Pacific Terminal Lake Plan referred to above, advocated by several engineers at the time the present canal was being planned, and before that by one of the early French Engineers, would increase the capacity of the canal by putting Miraflores Lake between the last lock lift and the entrance to Gaillard Cut, thus providing an anchorage area for Atlantic bound ships above the locks in case the cut were too foggy to navigate. Now ships have to wait below Pedro Miguel lock or out at sea until the cut is clear.

The theory is that in bad weather a good many ships could accomplish the slow process of locking-through whereas now the locks are idle if the cut is shrouded in fog. In any such improvement scheme, of course, the new locks could be built of increased size and efficiency (some of as much as 200 ft. width, 1500 ft. length and of two-lift design, having been studied), which would further augment the canal capacity. Also, most of the schemes studied have contemplated raising the level of Gatun Lake from El. 85 to El. 92 to increase the supply of lockage water.

As to increased security, the supposition apparently is that a concentration of all lock lifts in one place would also permit more effective concentration of protective facilities and defensive measures. Additional se-

curity could also be achieved by separating the two lanes of any new locks safe distances from one another.

Conversion of canal to sea level

But is any type of lock canal secure in the sense that Congress used the term in the request for the study? The decision of the investigators on that point is vital. One has only to recall the movies of the Bikini atomic bomb tests, where a column of water that looked to be half a mile across was thrown several thousand feet in the air to visualize what would happen to a lock. Or look at the hole in the ground caused by the explosion of a hundred pounds of dynamite and interpolate to the equivalent effect of millions of pounds of T. N. T. And once a hole were breached in a lock or one of the impounding dams, the lake would drain out, and no amount of repairs could restore the canal to service until rainfall and runoff refilled the lake. It is a sobering thought, and one that cannot be ignored under the mandate that Congress wrote into Public Law 280.

One way to eliminate the danger is to eliminate the lake and the locks, to convert the canal to a sea-level waterway. And there is ample evidence that the investigators are studying the possibilities long and carefully. For one thing, they have built a half-mile long model of a sea level canal to the alignment of the present lock canal to test the effect of tides on currents. They have set up criteria for improved alignment, and are having the Navy study the behavior of ships in canal models built to these criteria in the David W. Taylor testing basin at Carderock, Md. They have let design and study contracts in the U. S. for the development of dredges that can dig at unprecedented depths, as would be necessary in Gatun Lake. And they have recently tested tide gate and navigation pass layouts in their sea level model in the Canal Zone. All these activities point to unusual concern with the possibility of converting the present lock canal to one of sea level type.

Of the numerous ways by which the conversion could be effected, at least two are known to have been studied, one involving lowering Gatun Lake to sea level in stages, the other lowering it in one operation. They have been called the stage lowering plan and the deep dredging plan.

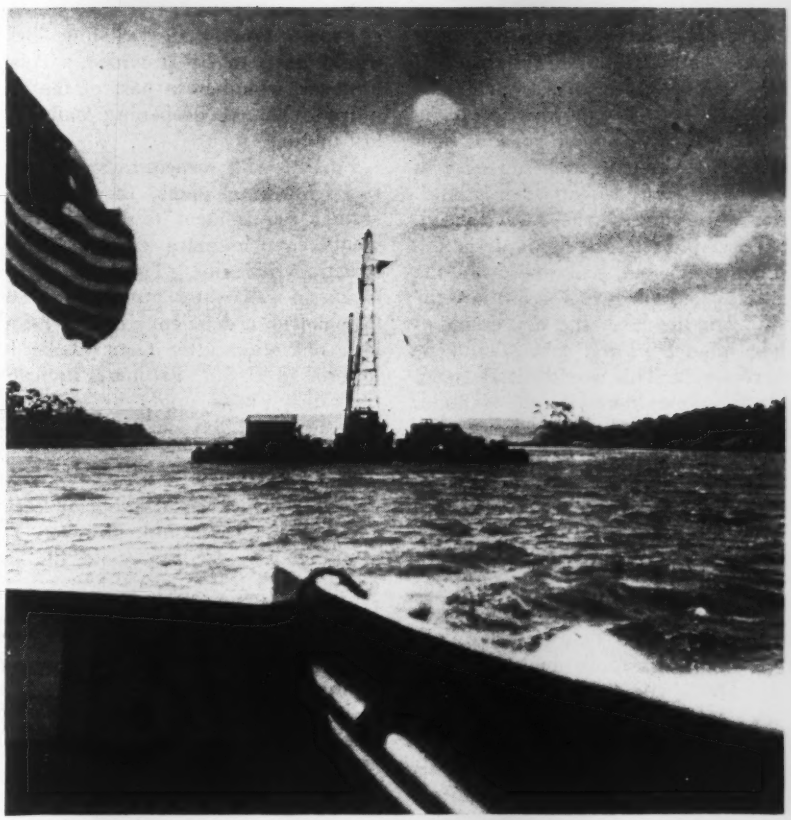


Fig. 7. Test drilling and blasting at unprecedented depths of 135 ft. below water surface are being carried out from a barge plant in the approach to the Third Locks cut on the Atlantic side.

To sea level by stages

The essential element of the plan for lowering Gatun Lake to sea level by stages is a temporary lock at each end to permit the passage of traffic at each lowering stage, first from El. 85 to 50; second from El. 50 to 20; and third from El. 20 to sea level. The location for these temporary or conversion locks is ready-made in the cuts that were dug for the Third Locks Project, ½ mile east of the existing Gatun Locks at the Atlantic end and ¾ miles west of Miraflores locks at the Pacific end, although some widening might be required if locks wider than the 140 ft. originally planned were deemed necessary. Should the Third Locks idea be abandoned, this plan thus provides an effective way to save a large part of the investment already made in that project.

Two variations of the conversion locks have been studied, one using a single-lane lock, the other a double lane. Since two lanes for traffic must be maintained during all lake-lowering stages, adoption of the single-lane conversion lock would require also that first one lane and then the other of the existing locks be modified to operate at the lower lake stages. This would entail a construction operation of considerable magnitude and difficulty, since the center wall between the existing locks would have to be underpinned during the time that the upper chamber of one lane was being removed so that this lane could be available for traffic when the lake was lowered to El. 50. Later, when the other lane was cut down from El. 85 to El. 20 to serve traffic at this lake level, the same ticklish operation would have to be repeated. As a corollary of the construction difficulties of this method there would be considerable risk, for a failure of the center wall might result in draining the lake.

The two-lane conversion plan is both simpler and more certain, for it would permit complete abandonment of the existing locks during the lowering stages. The idea would be to make the conversion lock of one-lift design, capable of being used at all stages from El. 50 to sea level. While the lock at the Atlantic end, for example, was being built in the Third Locks cut, seaward from the unexcavated plug that separates the cut from the lake, the deepening of the channel in the lake would be carried out. This would entail dredging to a maximum depth of about 85 ft., (present water surface, El. 85, minus future water surface, El. 50, equals 35, plus a 50 ft. channel equals 85 ft.) Such a depth is well within the capabilities of contemporary dredging equipment.

Once the channel was deepened, the plug ahead of the conversion lock would be blown out, and the lake water surface rapidly lowered to El. 50. Then, with the two-lane conversion lock in constant service, the channel could be deepened as the water surface was progressively lowered until the bottom of the excavation reached project grade of 50 ft. below sea level (and increasing to 60 ft. at the Pacific end because of the greater tide variation there).

At the Pacific end the conversion plan would be only slightly different. The single-lift conversion lock would be built in the Third Locks cut at Miraflores. When it went into service, as the Gatun Lake water level was dropped to El. 50, Pedro Miguel lock, which operates between El. 85 and El. 50, would be high and dry. Since the Third Locks cut at this location was hardly more than begun before that project was shut down, a bypass around the existing lock would have to be provided. This, however, would be a part of the required channel deepening and not lost motion.

Finally, with respect to any of the stage lowering plans, there is one special requirement to be met that would involve extra cost and construction difficulty. This is the provision of salt water pumping plants to make up a deficiency of water for lock operation after Gatun Lake is lowered to El. 50. Estimates indicate that such plants might have to aggregate over 4,000 sec. ft. in capacity.

Deep dredging plan

All of the expense and trouble of conversion locks could, however, be eliminated if dredges could dig as deep as 135 ft. below the water surface, i. e. from El. 85, existing lake level, to El.—50, the required sea level channel depth. It is the great appeal of this plan, as to simplicity and to probable lessened cost, that has led the investigators to award the special dredge-development contracts. Should this plan prove feasible it would only be necessary to dredge channels in Gatun and Miraflores lakes to El. — 50, and then knock out the protective plugs in the Third Locks cuts, draining the lake. There would be eight to ten days interruption to canal traffic while the plugs were being removed and the channels cleared of debris, but after that the sea-level canal would be a going concern.

Simple in concept though it is, the deep dredging plan raises some puzzling questions. One of these is basic: Can dredges be designed and built to dig at 135 ft. depths, and fast enough to be practicable from a cost standpoint? To find out, two contracts have been awarded, and to date the results are encouraging.

One of the contracts, covering both the design of a hydraulic cutter-head dredge and studies and estimates of a construction plan, is held by a combination named Panama Contractors and consisting of Gahagan Construction Co., Standard Dredging Co. and the Atlantic, Gulf and Pacific Co. Their contemplated dredge is said to have a 46-in. suction and a 40-in. discharge, and to incorporate the unique feature of a booster pump set about 65 ft. down on the 135 ft. long boom. Lifting and swinging gear would be of unprecedented size, and large buoyancy tanks would help support the boom. The spuds on this huge machine would be 150 ft. long, the lower 80 ft. of which telescopes into the upper part as required for adjustment.

The second deep dredge contract covers design only of a bucket ladder dredge and is held by the Yuba Manufacturing Co., specialists in these types of dredges. Although ladder dredges with $\frac{3}{4}$-yd. buckets have operated at 124 ft. depths in California gold mining work, nothing approaching the high capacity and 135 ft. depth required for the Panama dredging has ever been built. Buckets as large as 6 cu. yd. were investigated, but it is believed that the greatest efficiency, relating power input to excavation production, can probably be attained with 2 cu. yd. buckets. Designed so that six such buckets would always be in contact with the bottom, a ladder dredge, it is claimed, would provide an efficient

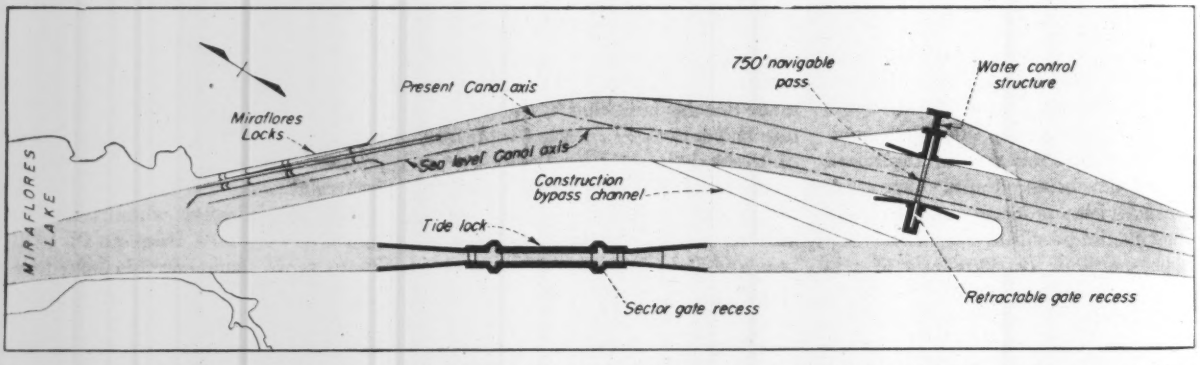


Fig. 8. One of the tide control schemes studied locates the necessary structures in the vicinity of the present Miraflores Locks. A tide lock is placed in the existing Third Locks cut, a navigable pass, with retractable type gates, in the present canal and a tainter-gate water-control structure in an adjacent bypass channel.

means for digging at 135 ft. depths.

Large dipper dredges, although impracticable for such deep work can be used for slightly shallower digging, particularly in hard material, and the Bucyrus-Erie Co., holds a third design contract for such a machine capable of working at a 90 ft. depth. With a 20-yd. bucket for hard digging and a 30-yd. size for softer material, the use of four 250-hp. motors on the main hoist of such a dipper dredge, supplemented by a 165-ton counterweight, would provide speedy operation and large production. For all of the proposed dredges there seems to be a preference for self-contained diesel-electric power units rather than relying on an outside energy source. The cost of any one of the dredges, it is rumored, might run as high as $5 million.

Another important consideration in the deep dredging plan relates to drilling and blasting procedures under such great depths of water. Such work has never been done before, and powder-company estimates of the amount of explosives required are quite variable—from 2 to 4 lb. per cubic yard of rock removed as compared to conventional charges of ½ to 1 lb. Tests now under way in the Atlantic approach to the Third Locks cut, however, prove that the Gatun sandstone, a relative soft rock, can be broken to sizes for handling by any of the contemplated dredges with only slightly over 1 lb. Similar deep drilling and blasting tests are planned in the hard basalt rock that prevails on the Pacific side.

Powder costs could, however, be doubled or tripled without any important consequence. Getting the holes down is what will run into big money. The actual drilling at great depths adds no new difficulties, according to the present tests, so that the crux of the drilling question will be speed and how to attain it; whether by exceptionally long drill steel or by the development of techniques to connect more conventional lengths rapidly; whether by a few super size drill boats or by large numbers of smaller ones; and whether by rotary or percussion type drills.

Tide control

Any sea level canal, no matter how or where built, will require a number of auxiliary structures and special

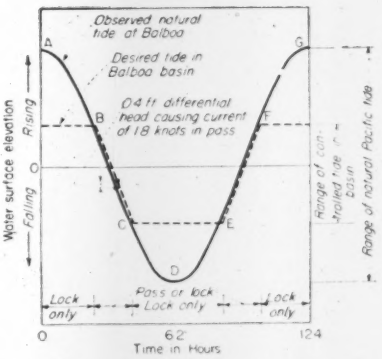


Fig. 9. How tide control structures would be operated at various stages of tide cycle. Between B and C flow would be out of canal through water control gates, and between E and F the flow would be into the canal. During these periods ships could use the pass.

construction operations. Thus, structures that will exclude unwanted currents, as from tides or from entering rivers, are of prime importance; while the necessary canal alignment to assure ease of navigation and the required side slopes to obviate slides will affect dry as well as wet excavation practices.

A great deal of design effort and model study has been expended on the subject of tide control, since the large difference in tide ranges—20 ft. maximum on the Pacific side and only 2 ft. on the Atlantic—would be expected to generate a considerable current. Actually the maximum velocity has been shown on the sea-level model to be only 4.2 knots, and interestingly enough this occurs at the Atlantic end and farthest removed from the high Pacific tides that create it. Nevertheless, this is considered excessive for ordinary merchant ship operation in a canal much of whose bottom and banks would be rock, as contrasted with the sand in the Cape Cod Canal where such a velocity occurs, and means are being sought to reduce it.

One method, and the one proposed in the majority report on the original canal in 1904, is to use a barrier dam and locks. But since it would take time to lock every ship entering or leaving the canal, even though the average lift would be only about 6 ft. and the maximum 10 ft., the present investigators have been studying a "navigable pass" arrangement similar to those used on the Ohio River, by which ships could pass between canal and ocean at certain tides stages without using the locks. Not only would this speed canal operation, but the navigation pass layout would provide maximum security from bombing since, if hit, the closure dam could be quickly dragged out of the way. Then the canal could be used without tidal regulation, which is deemed practicable in an emergency.

An opening could of course be cleared through a barrier dam and lock, if they should be bombed, but it would be a time-consuming operation. Moreover, it is believed to be the present thinking of the investigators that use of the navigable pass would so familiarize the pilots with open water operation of the canal that they would be ready for any emergency, whereas the lock and dam plan would not permit this advance training.

Elements of navigable pass plan

The proposed navigation pass layout would include three elements—the pass equipped with a movable dam, a set of locks and a gated water-control structure. Just how these would be arranged would depend upon the location chosen for the tidal control works. One of the arrangements tested on the sea-level model places the tide lock, equipped with sector type gates, in the Third Locks cut at Miraflores; the navigation pass, with a 750 ft. wide opening, in the approach to the present canal; and the water-control structure, of whatever width necessary, beside it. An interesting aspect of this arrangement is that the tidal lock could temporarily be increased in height and used as the conversion lock should the stage lowering plan of canal conversion be adopted.

From the layout on the sea level model it is apparent that the designers are thinking of a retractable type dam across the navigation pass. And, since the dam must be capable of withstanding a 10-ft. hydrostatic head on either side, a triangular cross section steel box has been chosen. Mounted on rollers, the prototype dam would be 80 ft. high, extending 60 ft. below and 20 ft. above the sea bottom. One contemplated way of operation is by hydraulic pressure, introducing water into the retracting chambers to close the dam and evacuating the water to open it.

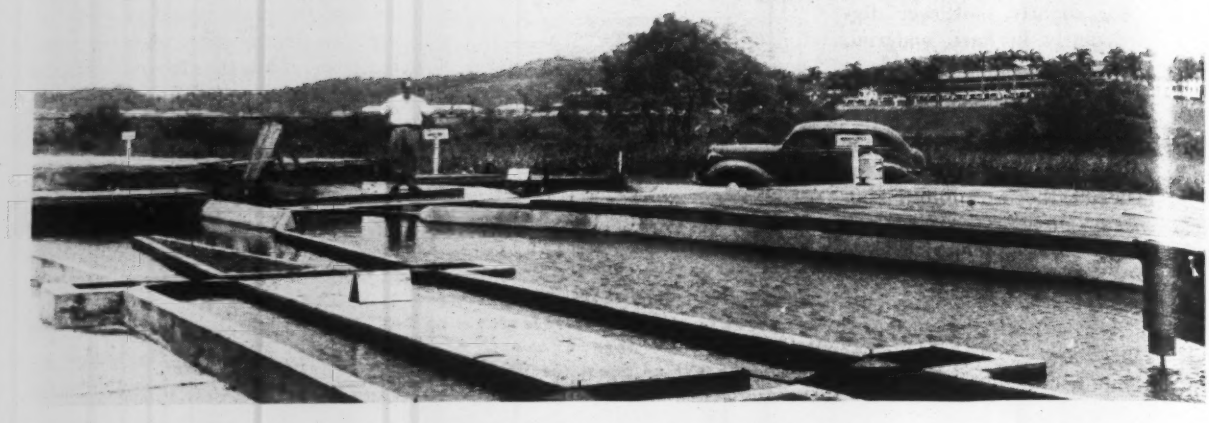


Fig. 10. Tide control structures simulated in the half mile long hydraulic model of a sea level canal built to the alignment of the existing canal. To the left is the tide lock, the man is standing over the navigable pass gate and to his left is the water control structure. During tests the model is covered with canvas, as at the right, to shield it from the wind.

The water-control structure involves a normal tainter gate set-up, its purpose being to bring the pool elevation inside the navigation pass to the tide elevation outside as early in the tide cycle as possible so that the navigation dam can be open the maximum length of time. Under the tentative criterion of a maximum permissible current of 1.8 knots (3 mph.) the tests indicate that the navigation pass can be used on an average of one third of the time, or from 1½ to 3½ hr. out of each 6 hr. tide change depending upon the time of year.

How the tidal variations in the model are produced is of interest. The model itself, built to a geometric scale of 1:100, is a half-mile long slab of 4-in. concrete laid to the alignment of the present lock canal and supporting concrete curbs to simulate the canal slopes and define the channel. At each end are basins representing Balboa and Cristobal harbors, and to these a constant amount of water is supplied. Then, by wasting varying quantities of this water through an electrically-operated gate, the desired tide elevations in the harbors are obtained.

The waste gate is controlled by a special tide apparatus, chief element of which is a cam whose shape was scribed by a polar plot of the tide elevations at each hour of the cycle. Connected to a time mechanism this cam keeps the waste gate as far open or closed as the tide at a particular time in the cycle requires. Water levels in the canal during the tests are measured by automatic recorders, and velocities by pygmy current meters or by time-exposure pictures of floating confetti.

Flood control

One of the requirements of a sea-level canal will be complete exclusion of entering streams. It would be expected that flood flows would have to be kept out, but recent tests indicate that even smaller flows, which could otherwise be carried by the canal, create objectionable currents. Salt and fresh water do not mix quietly.

Fig. 11. Col. James H. Stratton in charge of "Isthmian Canal Studies — 1947" on an inspection of the model of a sea level canal that has been constructed in the Canal Zone.

Were the Panama Canal to be converted to sea level, such important rivers as the Chagres and the Gatun from the east and the Trinidad and Cano Quebrado from the west would have to be blocked and the water carried to the sea through diversion channels. A dam would no doubt be required at Gamboa on the Chagres to impound the excess runoff of that stream, which is not now held by the existing Madden Dam farther upstream. But it would probably not have to be as high (in view of the supplementary effect of Madden) as the one proposed for the same location in some of the original canal plans and which then caused so much discussion with respect to foundations and type of structure. Moreover, our present knowledge of dam building generally and of foundation conditions at the site is far advanced over that of 40 years ago.

Improved channel alignment

One of the necessities for a safe canal of ample capacity is an alignment that permits easy handling and maneuvering of ships, and the present canal is far below a reasonable standard in this respect. The investigators have, therefore, devoted much attention to this subject, since it is appropriate to any canal route that is to be chosen.

As a target to shoot at and test, rather severe criteria were set up.

These include a 500 ft. wide channel bottom, a 50 ft. depth, curves of 20 deg. maximum deflection angle (some of the present ones are near twice that), sight distances on curves of not less than a mile, and 5-mile tangents between curves. These dimensions and others, both more severe and more conservative, are being tested in the Navy model basin at Carderock, Md., where the handling of model ships under various current conditions will also be studied. When conclusions are reached, the outdoor sea-level model in the Canal Zone will be rebuilt to the new criteria as a further check on performance. Since all studies are based on providing ample canal capacity up to the year 2,000 such modern and future navigation aids as infra-red lights, fog dispersal equipment and radar and electronic devices are not being overlooked.

Whatever the alignment and dimensions chosen, they will materially affect the cost and construction methods of a canal, lock or sea level, since a greater or lesser bottom width or degree of curvature brings different geological formations into the picture with their differing side slopes that are safe from sliding.

Geology poses many problems

The area traversed by the present canal is noted for its upside-down geology, hard rock occurring regularly on top of soft material. It was the weight of this cap rock that initiated much of the disastrous bank sliding in the early days of the present canal, and great care is being taken to avoid any return engagements on future construction. Evidence of the seriousness of this situation is contained in the figures of the amount of slide material removed from the present canal: 23 million yd. before water was turned in in 1913, and about 50 million yd. in the following 10 yr.

Every opportunity is, therefore, being used to gain new knowledge through tests and study of past experience. Many data were collected during the Third Locks design and construction, and continued maintenance of the canal banks for over 30 years has produced many more.

Not being blessed with these data nor with our present knowledge of soil mechanics and engineering geology, the designers of the present canal, whose decisions on so many vital matters have stood the test of time, used bank slopes of 3 horizontal to 2 vertical for all materials. For any new canal, slopes will be varied, and there seems to be complete confidence among the investigators that both safe slopes and bearing pressures can be set, and that correct construction procedures can be outlined, certainly for any canal in the vicinity of the present one.

For one thing they have determined that the Cucaracha clay, the famous slide material, will stand on relatively steep slopes (1 vertical to 3 horizontal) when it occurs alone, which is about the same as for the similar but harder Culebra formation, but that if overlaid by such hard and heavy rock as agglomerate or basalt the Cucaracha slopes must be quite flat, 1:5 or more. For safety and eventual economy, much of the overlying hard rock would have to be removed.

The Third Locks cuts indicate that Gatun sandstone will stand on a 6 vertical to 1 horizontal slope, and that 12:1 is safe for agglomerate and basalt: for the latter, berm widths and spacing criteria have also been established. Extensive loading tests have demonstrated that Cucaracha will safely carry 6 tons per sq. ft., while the harder Culebra, upon which the Pedro Miguel locks are founded, will carry 15 tons. It is facts such as these that give the investigators confidence in designs and construction methods being assumed for the purpose of their estimates.

As to devising actual construction

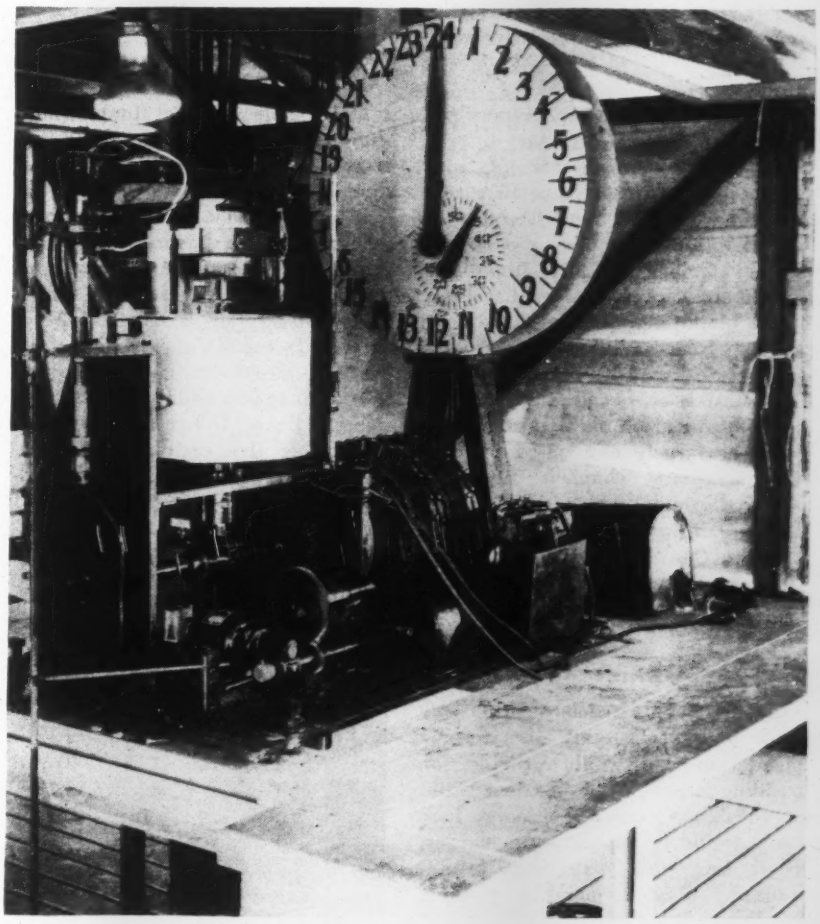


Fig. 12. Tide producing mechanism at each end of the hydraulic model. The cam at the left, whose outline represents a polar plot of the tides in a 24 hr. period, is moved by a time device and actuates a float valve which admits the proper amount of water to the canal. Tide variations are recorded on graph paper wound on the drum.

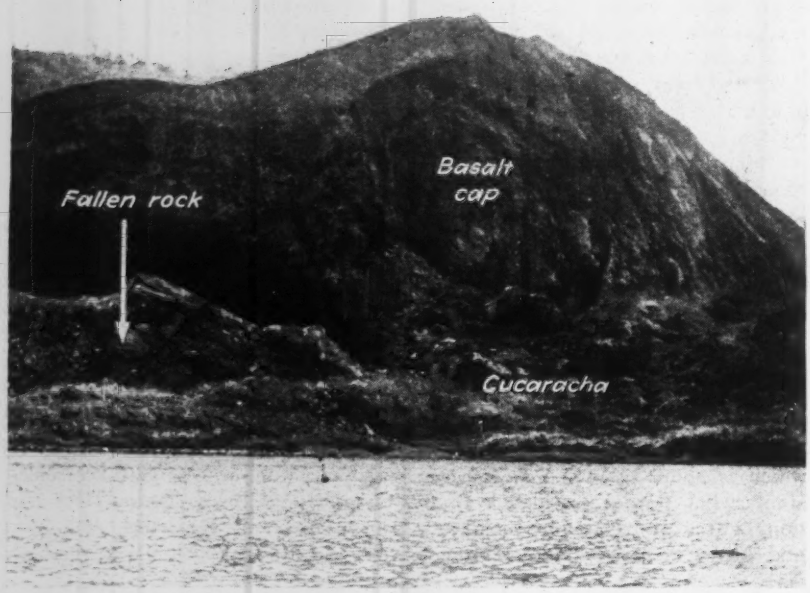


Fig. 13. One type of slide on Panama Canal is caused by weight of hard basalt cap on soft Cucaracha formation creating a tendency for the latter to heave in bottom of canal. In future construction, the basalt cap would be removed.

methods, the present studies are going only so far as is necessary to prepare the cost estimates for construction periods of either 10 or 15 years. It is, nevertheless, understood that one of the most promising possibilities for moving the huge quantities of dry excavation involved has been shown by the studies to be a combination of batteries of 30-yd. shovels and barge disposal. Some recasting of material by draglines would be necessary to reach the barges, or this could be largely eliminated by digging auxiliary channels into the banks through which the barges could be towed to within reach of the shovels. With a half billion yards of dry excavation to be handled, large and expensive plant layouts are obviously justified.

Two canals in place of one

Earlier in this article mention was made of the possibility of a recommendation that would provide for building a new sea-level canal while at the same time the present lock canal would be kept in service. San Blas, Caledonia Bay and Atrato-Truardo were among the possible locations, but there are also routes near the present canal, and particularly one known as the Panama Parallel Route, that have also been seriously studied.

This Panama Parallel Route, whose alignment corresponds closely to that of the present canal except that it eliminates the big bends in the latter, is an original conception of the present investigators growing out of their studies of several routes having a Pacific terminus in Chorrera Bay a short distance outside the west boundary of the Canal Zone. One of these routes crosses the isthmus to the small town of Lagarto and is entirely outside the Zone. It has the advantage of offering dry excavation for the major part of its length, but the yardage would be formidable and the construction of new ports and harbors at both ends would entail tremendous expense, with Lagarto being practically in the open sea.

To eliminate the problems of Lagarto, two other Chorrera routes with Atlantic terminals near those of the present canal in Limon Bay were studied, followed by the next logical idea of shifting the Pacific terminus from Chorrera to the vicinity of Balboa on the present canal. Thus the Panama Parallel Route came into being.

A common element of all these routes was a crossing of Gatun Lake that would be blocked off by barrier dams, which would also provide flood protection from the various lake-feeding streams. By digging the other sections of the canal first, the resulting spoil could be used to build the dams after which the Gatun Lake sections could be excavated in the dry behind their protection.

This idea has great appeal, its principal drawback being, of course, the tremendous dam building job involved, since the total barrier dam length would exceed 14 miles. A conventional cross-section of say 100-ft. top width would not be too serious, but if this were increased 10, 20 or 30 times to provide security against modern weapons, grave doubts arise as to the advisability of the scheme. Nevertheless, once built, it would undoubtedly represent a reasonable solution of the problem that Congress set up. In the final analysis, also, it will have to compete with one

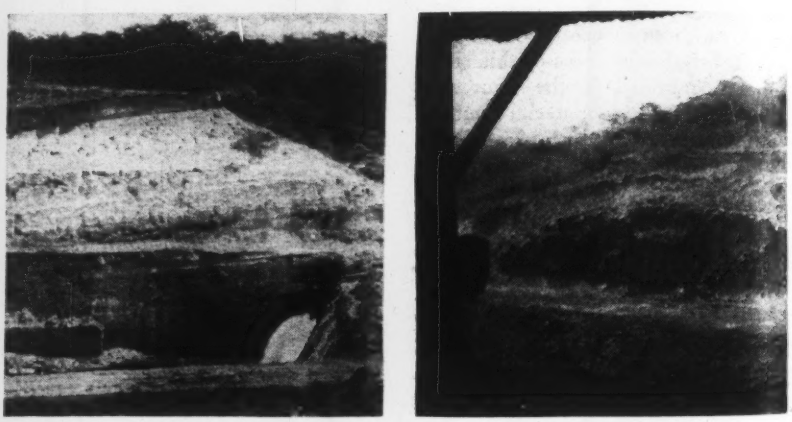


Fig. 14. Varying geology along the Canal is emphasized by formations in the Third Locks cuts. Left: Gatun sandstone at Atlantic end. Right: columnar basalt at Pacific end.

of the Panama conversion plans on the basis of cost.

The situation summarized

What then are the possibilities of solving this puzzle in Panama? What considerations must be resolved to come up with a recommendation for a canal that will best meet the requirements of security and ample capacity set up by Congress? Among the obvious ones are sound engineering, practicable construction and minimum possible cost. To which must be added resistance to or possible protection from the destructive effects of present and future weapons of war. Adding up these considerations as they apply to each of the proposals and then comparing the results is the present task of the investigators. It is futile, and it would be improper, to anticipate or speculate upon their conclusion, but a few applicable facts will serve to summarize the situation as it now exists.

There are four routes removed from the present canal and three in the vicinity of it whose merits must be weighed. Of the former, three are sea level routes whose yardages, estimated on a 1:1 bank slope assumption are as follows: Atrato-Truando, 1,590 million; San Blas, 1,520 million; and Caledonia, 1,260 million. What these yardages would prove to be were sufficient knowledge available to use geological slopes in estimating them is problematical, but they would increase rather than diminish judging from the Panama Conversion Route; using 1:1 slopes, this plan required 688 million yards, which increased to 917 million when geological slopes were applied.

Any one of these sea-level routes thus might require up to 2,000 mil-

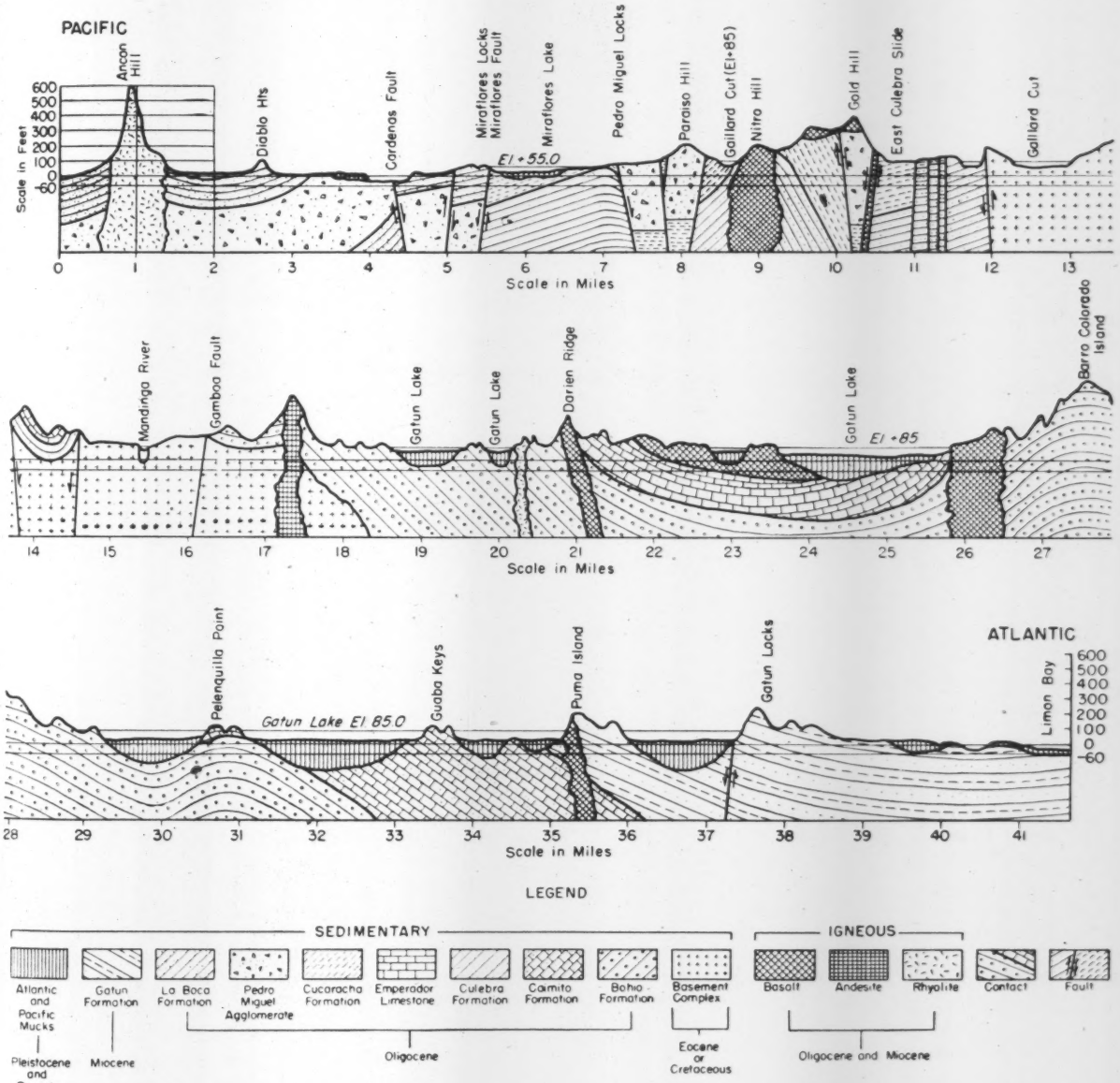


Fig. 15. Geological sections across the Isthmus of Panama at the Canal Zone indicating the types of formations to be excavated to convert present canal to sea level.

lion yards of excavation. It is also pertinent to note that they are in isolated locations without terminal ports or harbors, and that the construction problems to be met are uncertain and difficult to appraise. On the credit side any one of them would provide a route supplementary to the present canal, not only far removed from it, but devoid of locks, so that requirements of both security and capacity could be satisfied. It would seem that cost and construction difficulties relative to the other routes—and perhaps political considerations—would be the determinants in deciding whether one of these three crossings would be recommended.

The Nicaragua lock canal has many advantageous aspects. Topographical and geological conditions of the route are well defined. Excavation would be less than for a sea-level canal. On the basis of the 1931 cost estimates, the present cost might be fixed in the neighborhood of 1½ billion dollars. Political considerations are favorable since the Nicaraguan government has offered complete cooperation. From the standpoint of dispersion, canals in Nicaragua and Panama would satisfy security to the degree that a lock canal can be considered secure; or, stated in another way, to the degree that they increase the difficulty of an enemy to deprive us of a trans-isthmian crossing. This latter consideration is the one to be resolved in deciding for or against recommending the Nicaraguan route.

The Chorerra routes in Panama offer the possibility of a sea-level canal with a minimum of wet excavation. Topographical and geological conditions are reasonably well known, which may or may not be an advantage since they presage expensive harbor and port facilities and total excavation of over 1¼ billion cu.yd. A distinct disadvantage is that their construction would require an enlargement of the Canal Zone and removal of one or both terminals from the vicinity of existing Panamanian cities.

The Panama Parallel Route would permit a sea-level canal to be built in the Zone without disturbing the present lock canal. By its construction we would have two canals, although their proximity one to the other would raise question of complete wartime safety. Construction could be done in the dry, but the building of the barrier dams required to hold back Gatun Lake would be a task of great magnitude, while their breaching in case of attack might put both canals out of service. Relative cost and security from attack are the factors to be considered in choosing this interesting scheme.

Converting the present canal to sea level will entail less total excavation than on any other sea-level route and probably no more than for a lock canal in Nicaragua. Terminal facilities are established and thus do not enter into the future costs. On the other hand, the necessity for dams and diversion channels to control floods in intersected streams and for temporary locks to maintain traffic through the canal during the construction period will add greatly to the expense. If deep dredging is feasible, construction difficulties and costs will be greatly lessened, but even if the alternative of building temporary conversion locks, as required for stage lowering of Gatun Lake, is necessary, no insurmountable troubles are involved. As a matter of fact, the deep dredging and stage lowering plans are not mutually exclusive initially. It would be possible to start with either one and then shift to the other after the first two or three years of preliminary work, without appreciable loss of time or money.

Finally a sea-level canal undoubtedly offers the greatest assurance of security and of minimum interruption in wartime, since damage from bomb hits could be repaired by dredges in a matter of days as contrasted with the many months that a lock canal would be out of service if its water supply should be lost. The sea level canal also promises no real navigation hazards because of tidal currents. Cost is the principal question upon which a recommendation favoring conversion of the present canal to sea level is believed to rest.

In so far as improving the present lock canal is concerned the Pacific Terminal Lake Plan is the one to be weighed and compared. Building the new, enlarged two-lift locks required, and dispersing them as much as necessary for safety, makes this by no means a low cost solution. Here, too, relative cost and security will control the decision.

In summary, the choice of the investigators must rest between supplementing the present canal with another removed a safe distance from it or converting the present canal to sea level. After that the choice shifts to Congress and the American people. If they want a safe canal badly enough to invest what it costs—1 billion, 2 billion, perhaps 3 billion dollars—they can have it. If security comes too high, and they will settle for increased capacity, any one of the schemes mentioned earlier in this article for improving the present canal, including completion of the Third Locks Project, will suffice. Upon such a decision rests finally the solution to the puzzle in Panama—and incidentally the silencing or the resurrection of the ghost of a sea level canal.

Consultants on the work

In addition to the staff of the investigation numerous consultants have been engaged on the work, as mentioned earlier in this article. Most important of these, of course, are the members of the consulting board, which consists of Rear Admiral John J. Manning (C.E.C. USN) Chief of the Bureau of Yards and Docks; Brig. Gen. Hans Kramer (C.E. Retired); Prof. Boris A. Bakhmeteff, Columbia University; Joel D. Justin, consulting engineer, Philadelphia; W. H. McAlpine, office of the Chief of Engineers, Washington; and H. M. Hill, Northern States Power Co., Minneapolis.

Harvey Slocum, well known construction specialist, has advised upon construction plans and estimates, while such experts from the office of Chief of Engineers have been called in as Gail A. Hathaway on flood control, Carl Giroux and B. W. Steele on dams and hydro power and Leon Zach on construction camps and permanent town planning. Soil mechanics and foundation guidance is being supplied by Professors H. M. Westergaard, Arthur Casagrande and L. Don Leet of Harvard University and E. M. Fucik of Chicago. Prof. Roland Kramer of the University of Pennsylvania has made extensive studies and advised upon canal traffic growth.

Lessons Taught by Wood-Truss Failures

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***Contents in Brief**—Analysis of several failures of split-ring connector joints of timber trusses points to the need for modifying the customary rule for calculating the allowable load on one split ring of a group. Concentric installation of 4-in. split rings on opposite faces should not be permitted in members less than 2⅝ in. thick, and the net section at joints should be checked, using a low tensile stress.*

DURING THE WAR, several cases arose involving failure at the split-ring connector joints of timber trusses and were made the subject of considerable study because the cause of the failures was not immediately apparent. Well constructed of reasonably good material, the trusses were designed under the War Production Board's "National Emergency Specification for the Design, Fabrication, and Erection of Stress Grade Lumber and Its Fastenings for Buildings", Directive No. 29, Aug. 1943, which is the same as the 1944 specification of the National Lumber Manufacturers Association. It is the purpose of the following analysis to examine the cause of the failures from the consideration of a typical case, and to draw conclusions therefrom relative to design.

The trusses under consideration are flat-top Pratt roof trusses of Douglas fir, each having ten approximately equal panels and a span of 57 ft. In Fig. 1 are shown three end panels of each truss, the supporting columns appearing at the extreme right. The truss in the foreground will be called Truss 1 and the truss immediately beyond Truss 2. In Fig. 2 is shown a view of Truss 1 from the opposite side. It will be noted that the trusses were shored up, subsequent to failure, adjacent to panel point L 3 and underneath a hanging plaster partition that occurs at this panel point.

From Fig. 1, it will be seen that the end diagonal (U_0-L_1), composed of 2—2 x 12's, has failed in trusses 1 and 2 due to slipping of the connection at the lower end. It will also be seen that in Truss 2 the second diagonal (U_1-L_2) composed of 2—2 x 10's, has also failed at the lower connection. To determine the cause of failure, these three joints were opened up by removing one half of the lower chord member so as to expose the diagonal at the joint.

A further examination of Fig. 1 and 2 shows that the second diagonal of Truss 1 has failed at the upper end, where there are two plain bolts and two bolts with connectors, and the third diagonal has also failed because of slipping of the lower end on one side and the upper end on the opposite side. It is of interest to note that these failures did not occur, or at least were not noticeable, until nearly two years after the building was completed, which substantiates the fact that timber will resist greater stresses over a short period of time than a long one.

Failure of joints described

In Fig. 3 is shown Joint L_1 of Truss 1 indicating the manner of failure, and in Fig. 4 the line of failure has been sketched on a detail of the same joint. Joint L_1 of Truss 2 failed in exactly the same manner and and for that reason the photograph of that joint is not reproduced.

It is believed that this failure may be classified primarily as a tension failure, the wood having broken on the reduced section between the ring grooves in the opposite faces of the member. There is no evidence of bearing failure, and the cores of the

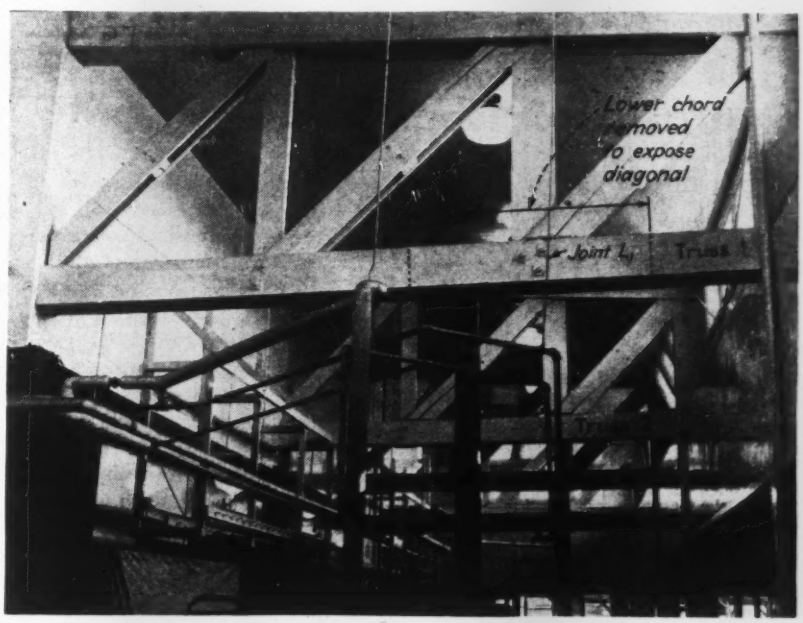


Fig. 1. Failures occurred in the split-ring connector joints of roof trusses 1 and 2. Column supports are at the right and shoring applied after failure at the left under the hanging plaster partition.

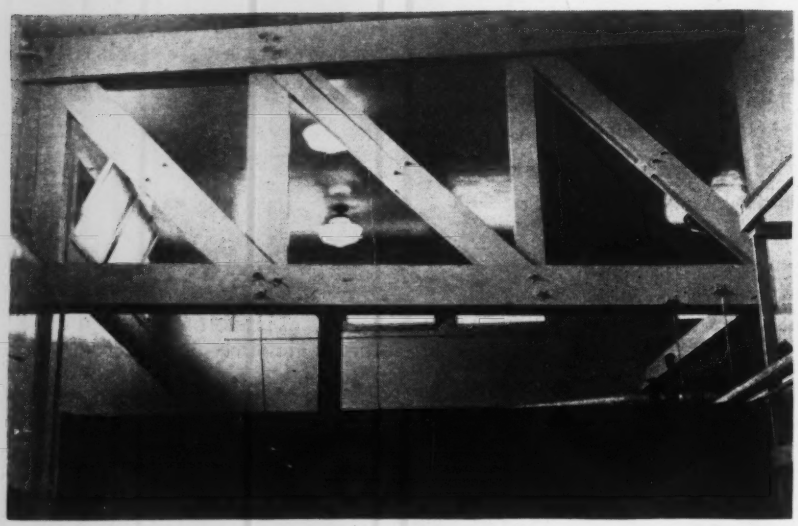


Fig. 2. View of Truss 1 showing other side from that in Fig. 1. Failure at upper end of second diagonal is very evident.

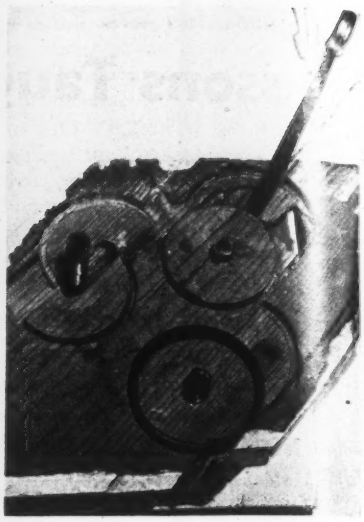


Fig. 3. Joint L_1 of Truss 1, with diagonal exposed showing tensile failure.

rings have either not sheared off at all, as in the case of the center ring, or they have only partially sheared as in the case of the other two rings. This indicates that the rings, acting as dowels, were not loaded to capacity before the joint failed. In a typical load test of a properly designed split-ring joint, the primary failure is a shearing off of the ring cores, each ring and core then acting as a solid dowel.

The total sectional area of Joint L_1 of Truss 1, on which tensile failure occurred, is 4.5 sq. in. Probably little shear resistance on lines parallel to the grain was developed, due to wedging action that produced cross-grain tension and caused the wood to separate on these lines. This action was very noticeable in Joint L_1 of Truss 2, in which the line of break parallel to the grain opened up nearly half an inch.

If resistance because of shear is neglected, the ultimate tensile strength developed in the wood is only 2,100 psi. The author has been unable to find any published reports of tests of timber in direct tension, so that no verification of this relatively low ultimate strength can be obtained. Perhaps the low value is attributable to stress concentrations at abrupt changes in section such as occur in a connector joint.

In Fig. 5 is shown Joint L_2 of Truss 2 with the rings and loose pieces of wood removed to indicate the manner of failure. In Fig. 6 is a detail of the same joint. This failure is due to a combination of tensile failure and shearing out of the wood on the plane at the bottom of the ring grooves. It will be noted that the wood has sheared out between the rings, indicating too close ring spacing. The piece of wood bounded by the line of break shown in Fig. 6 is loose and has

ANALYSIS OF DESIGN OF TRUSS JOINTS

Joint Data	Joint L_1		Joint L_2	
	Diag. to Vert.	Diag. to Chord	Diag. to Vert.	Diag. to Chord
	Vertical Loads			
Size of split ring—in.	4	4	4	4
Thickness of piece—in.	1⅝	1⅝	1⅝	1⅝
No. of faces with rings	2	2	2	2
Angle of load to grain—deg.	43	47	45	45
Stan. des. load, one ring—lb.	3,340	3,250	3,300	3,300
Edge distances—in.				
Diag. (loaded edge)	3	3	3.5	3.5
Vertical	3	.....	2.75	.....
Chord	.....	3	.....	3
Allowable load, one ring—lb.	2,940	2,820	3,150	3,150
End distances—in.				
Diagonal	3.75	3.75	4.0	4.0
Vertical	3.5	.....	3.5	.....
Allowable load, one ring—lb.	2,170	2,110	2,240	2,240
Spacing—in.				
Spacing	5.6	5.6	5.75	5.75
Offset	2.75	2.75	2.5	2.5
Angle axis of rings—deg.	29	29	26	26
Allowable load, one ring—lb.	3,000	3,100	3,100	3,100
Group of connectors	.....	.....	.....	.....
Allowable load, one ring—lb.	(1)	1,050	1,800	1,300
Load on joint—lb.	14,000	12,800	11,900	12,000
Number of rings	6	6	4	4
Actual load, one ring	2,330	2,130	2,975	3,000
Factor of safety	$\frac{2,300}{2,170}=1.07$	$\frac{2,130}{1,050}=2.03$	$\frac{2,975}{1,300}=2.30$	$\frac{3,000}{1,300}=2.32$
	Seismic or Wind Loads			
Allowable load, one ring	$1.5\times2170=3260$	$1.5\times1050=1570$	$1.5\times1300=1950$	$1.5\times1300=1950$
Factor of safety	0	1.35	1.52	1.54

(1) In this case the reduction formula for a group of connectors does not apply, since the angle of load to grain is not between 45 and 90 deg.

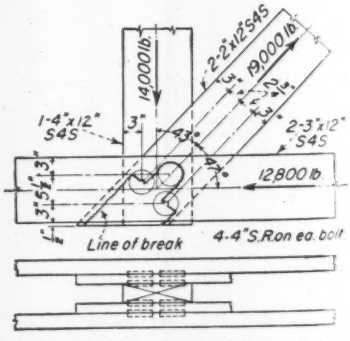


Fig. 4. Actual loads and line of break are indicated on detail of Joint L of Truss 1.

failed in tension at its upper end between the bottom of the ring grooves in the opposite faces. This tensile failure occurred before the lower ring, bearing against this loose piece, had reached its capacity in bearing or shear.

Design of joints analyzed

In the accompanying table is an analysis of the design of Joint L_1 of Truss 1 and L_2 of Truss 2, in accordance with the requirements of the "Teco Design Manual for Teco Timber Connector Construction" of the Timber Engineering Company, 1943 Ed. The tabulated joint data is in accordance with Fig. 4 and 6, on which are shown the actual stresses that existed in the truss members at the time of failure. It will be seen from the table that for each joint the actual load on one ring at failure is greater than the allowable load on one ring.

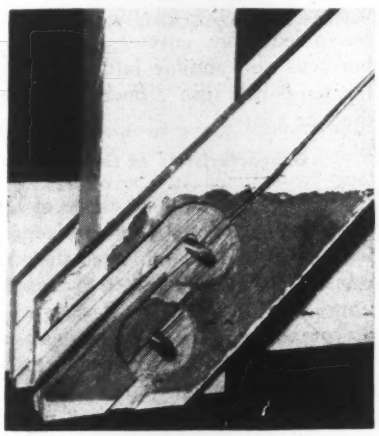


Fig. 5. Joint L_2 of Truss 2, with diagonal exposed. A combination of tensile failure and shearing out of wood at the bottom of the ring grooves is indicated.

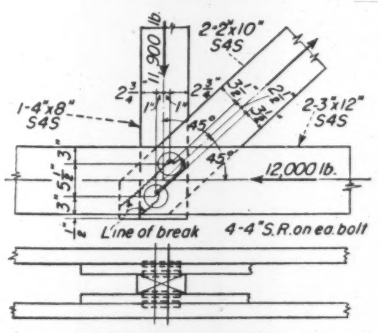


Fig. 6. Actual loads and line of break are indicated on detail of Joint L_2 of Truss 2. The allowable load on one ring was exceeded, as indicated in the table on the opposite page.

The cause of the truss failures is, therefore, improper design. However, as pointed out hereinafter, the factors of safety are believed to be much too low, and if they had been higher the trusses even though overloaded, probably would not have failed.

Considering first Joint L_2, we see from the table that the allowable load on one ring is determined by the load limitations for a group of connectors. This load limitation applies to cases in which the centers of the connectors are not offset from each other perpendicularly to the grain a distance equal to the diameter of the connector and when the angle of load to grain is between 45 and 90 deg. On this basis the factor of safety of the joint is 2.3. The Forest Products Laboratory ("Modern Connectors for Timber Construction", 1933, U. S. Govt. Printing Office) recommends a factor of safety of 4 for this type of connector, which follows the recommendation of Professor Kreuger, its originator.

In the case of Joint L_1, the allowable load on one ring in the connection of the diagonal to the chord is also determined by the load limitation for a group of connectors, and the resulting factor of safety is 2. However, for the connection of the diagonal to the vertical in this joint, the angle of load to grain is 43 deg., so that the load limitation for a group of connectors does not apply and the allowable load on one ring is determined by end distance. On this basis the factor of safety from the table is seen to be only 1.07. This result is obviously inconsistent, which leads to the conclusion that the load limitation for connectors in a group should apply to any angle of load to grain and not merely to angles between 45 and 90 deg.

Design changes indicated

On the basis of this analysis the following conclusions may be drawn:

1. 4-in. split rings should not be permitted to be installed concentrically on the opposite faces of a 1½-in. thick member. Although this is now standard practice, the former requirement, ("Manual of Timber Connector Construction", published 1935) of 2½-in. minimum thickness should be adhered to.

2. A low tensile working stress should be used for calculating the required net section at connector joints of wood tension members.

3. Rule 2 for calculating the allowable load on one split ring of a group of connectors, in which the centers of the connectors are not offset from each other perpendicularly to the grain a distance equal to the diameter of the connector, is not satisfactory. This rule should be modified so as to apply to all angles of load to grain and so as to give a greater factor of safety.

Mount Cenis Tunnel Reconstruction

Reconstruction of the French end of the Mont Cenis tunnel, on the line connecting the railways of France and Italy, was completed last year, and the first train passed through the tunnel in September, 1946. In September, 1944, the retreating Germans had blocked the French end of the tunnel, at Modane, with derailed trains, and then blew it up with mines, the explosions causing landslides or avalanches that swept away the approach line and the tunnel entrance, with trains and unexploded mines buried in the slides.

Repair work was begun in August, 1945, by driving an adit, 200 ft. long, at right angles to the line, in order to obtain access to the tunnel in rear of the wreckage, which extended about 166 ft. in from the original portal. This adit was completed on Oct. 4, 1945. According to a French paper, two side drifts were then driven towards the portal for the new concrete side walls. These were followed by a crown heading and lateral drifts for the concrete arch. A second adit was then driven from the side of the tunnel to facilitate removal of the core. Concreting the floor and invert completed the work. Heavy timbering and steel plate lining were required in the drifts and headings, as the whole mountainside, disturbed by the mine explosions, was unstable and shifting.

This work was done by contractors under direction of the engineers of the French railway system.

Why You Should Avoid . . . .

Housing Construction on Refuse Landfills

Rolf Eliassen
Professor of Sanitary Engineering
New York University, New York, N. Y.

***Contents in Brief**—Erection of veterans' emergency housing units in New York City called for the use of a 130-acre site that had been filled with rubbish and garbage some five years ago. Re-grading of the site and the opening of trenches for utilities exposed decomposing garbage with a resulting stench. Seeking to control these odors with various chemical compounds it was discovered that this could be done successfully using a commercial oxidizing agent sprayed on the exposed refuse. To cope with the problem of combustible-gas generation within the fill, all the houses were elevated above the ground and an aluminum-foil membrane was secured under the wood flooring. On the basis of these experiences, the conclusion is reached that landfills should not be used for purposes requiring excavation.*

SANITARY LANDFILLS have served many useful purposes in the reclamation of land formerly of doubtful value. In New York City thousands of acres of marsh and swampland have been converted to parks, airports, storage yards, and parkways. With the pressing demand for veterans' housing during the last year, it has been necessary to utilize landfill sites for a purpose quite different from previous experience. The use of sanitary landfills for housing projects has created a number of problems not ordinarily met by construction engineers. The nature of these problems, particularly those of odor control, and the methods adopted for their solution are the subject of this article.

In order to facilitate management and operation of housing projects in an economical manner it is necessary that a large number of dwelling units be located in one area, preferably of about 100 acres; not many areas of this size are readily available. Since the housing projects are to be operated by the New York City Housing Authority, it was preferred that the structures be built on land owned by the city. The temporary nature of the projects would not permit the expense of filling in large available areas of swampland with earth in order to create the necessary foundation characteristics of stable and well-drained land. For the convenience of the families of veterans it was essential that the housing be located near existing schools and transportation systems. In order to keep costs as low as possible, it was also expedient that the proposed sites be close to existing utilities such as water, gas, electricity, sewers, and storm water drains. All of these requirements narrowed the choice of sites to a relatively few locations.

Rego Park in the Borough of Queens satisfied most of the requirements noted. Here some 130 acres of property, mostly city-owned, were available awaiting conversion into a park for recreational purposes. This site, located at Horace Harding and Junction boulevards in the Elmhurst section of Queens, close to the high-valued apartment district of Forest Hills, had formerly been useless swampland 15 to 20 ft. below the grade of surrounding streets.

From 1939 to 1942 the Department of Sanitation had placed between one and two million cubic yards of mixed refuse to reclaim this mosquito-ridden area in the midst of a residential community. When the fill was placed it was not intended that it be used for any purpose other than recreational facilities. However, the adaptability of the general site for veterans' housing was such that the difficulties of building on a landfill had to be surmounted.

This article describes some of these difficulties in the preparation of the site for the construction of 367 houses comprising 1,424 dwelling units, all assembled from government surplus barracks and similar buildings built for temporary use elsewhere during the war years.

Characteristics of landfill

Studies made at the College of Engineering of New York University from 1939 to 1942 indicated that the refuse material contributed to the sanitary landfill at Rego Park varied in composition from 79 percent organic matter and 21 percent inorganic matter in July to the almost reversed values of 14 percent organic matter and 86 percent inorganic matter in December. The high percentage of ashes in the refuse during the winter months was the major factor causing the difference of constituents.

During the five years that the landfill has been undergoing decomposition a considerable settlement has taken place, with the attending consolidation of the refuse. Since the organic matter in landfills continues to decompose for periods longer than thirty years it is evident that a 5-year old fill is by no means stable from the standpoint of organic decomposition. The New York University tests on hundreds of composite samples taken from landfills five years old showed that approximately 15 percent of volatile organic matter was still in the refuse. The composite samples also showed about 4 percent fixed

carbon, mostly cellulose in nature, 0.2 percent organic nitrogen, and 25 percent moisture. Consequently a 5-year old landfill is in the process of active decomposition, with resulting gasification.

Experience has shown that although decomposition may continue to take place for thirty or more years it is not necessary to wait until ultimate stability is reached before proceeding with the use of the filled area. On the basis of 44 settling tests conducted as part of these landfill studies (*ENR* Sept. 10, 1942, vol. p. 369) it was concluded that the use of spread footings would permit a landfill over two years old to carry a load of 2,000 lb. per sq. ft. without experiencing a localized settlement greater than one inch. Pier or column footings could not be used because concentrated loads would lead to localized settlement and the nature of landfills is such that each footing might not undergo the same degree of settlement.

Gases of decomposition

The decomposition of organic matter in the fill gives off gaseous products. Hundreds of samples of gas generated in landfills were analyzed in the New York University landfill survey. These showed that fills four years old would give off gases of decomposition with the following average analysis:

Carbon dioxide	28%
Methane	56%
Nitrogen	15%
Miscellaneous	1%

It will be noted from the analysis that the constituents are not odorous gases. The major hazard arising from these gases is the presence of such a high percentage of methane, which renders the mixture highly combustible. Data on the quantity of gas given off per unit of time for a given volume of fill are not available.

Gases with this average analysis are being generated continuously in landfills throughout the country. No dangers are encountered as long as the gases diffuse through the two feet of earth covering the refuse and thence into the atmosphere. However, if these gases are contained in a closed space an explosive mixture may result, with attendant fire hazards. Therefore, any buildings constructed over landfills must contain provision for adequate ventilation under the floor of the structure as well as gas-tight floors.

Fig. 1. Installation of utility services (top) on the landfill area exposed decomposing garbage, the stench from which made it necessary to abandon work until a deodorant was applied. Successful odor control was accomplished with an oxidizing agent that was applied to the exposed areas (bottom) with an orchard-type agricultural spray rig.

Odors during construction

It must be understood that the gaseous products of decomposition are not the source of odors in well-operated landfills, as indicated by the analyses of the gases. However, when excavation takes place in a landfill and the organic matter in the refuse is exposed to the atmosphere, the inherent odor of the putrescible garbage passes into the air. A similar situation arises in sewage treatment plants where the gaseous products of decomposition are not odorous to any appreciable extent. However, when raw or partially digested sludge is exposed to the atmosphere it possesses an extremely obnoxious odor, which is inherent in the material itself.

At the Rego Park site it was deemed advisable from the economic standpoint to alter the drainage characteristics of the surface of the landfill area and thus change the slopes of the land. To accomplish this it was necessary to move more than a hundred thousand cubic yards of landfill material by means of bulldozers, carry-alls and other heavy earth-moving machinery. In some places an excavation as deep as eight feet was necessary to reform the topography. Putrescible organic matter was being continuously exposed, thus giving rise to offensive odors. In addition, trenches were dug for storm drains and utilities conduits, thus exposing additional material of a highly

Fig. 2. Heavy equipment was used to re-grade portions of the 120-acre site and this operation resulted in the exposure of previously buried rubbish and garbage. The latter, being in an active state of decomposition, created an odor condition that caused complaints from residents adjacent to the site.

objectionable nature. Many complaints were received from laborers who refused to work in the trenches as well as from irate citizens from the surrounding communities.

No problem arose from the presence of rats on the landfill. It has long since been proved that a properly conducted landfill is a safeguard against rats since harborage is eliminated and food sources are buried under a 2-foot cover of earth, which the rats cannot penetrate. The landfill at Rego Park was so conducted by the Department of Sanitation that rats were not present in the completed fill.

Fortunately, few fly difficulties were encountered from all of the exposed garbage because the excavation was performed during the fall months after the fly-breeding season had passed. If the work had been done during the spring and summer months it is conceivable that serious difficulties might have arisen with flies.

Solution to the site problems

Problems arising from the generation of gas were solved very efficiently by the design of the foundation and floors of the buildings. At the site of every building a 12-in. layer of cinders was placed over the earth covering the sanitary landfill. An air space ranging from 12 to 24 in. was provided between the top of the cinders and the floor. This air space was enclosed with wooden siding but was vented through screened openings on all four sides. Under the wooden flooring of each dwelling unit a gas-tight paper membrane, covered with aluminum foil, was secured. Thus, any gas generated in the fill under the building was vented to the atmosphere in such a manner that none of it could enter the building to endanger the occupants.

The load of the buildings was well distributed over the bed of cinders by means of spread footings made of 12-in. creosoted wooden sills. Resultant loads were only a small fraction of the permissible 2,000 lb. per sq. ft., which sanitary landfills may carry without appreciable localized settlement.

Odor control methods

From the standpoint of the citizens of the surrounding communities the greatest problem at the Rego Park housing project was the one caused by the odors. Complaints to the health department and the housing authority of the city were so numerous that it was deemed advisable to carry out special tests to determine procedures for minimizing the odors. These tests were carried out by the writer, with two inspectors of the health department and two men representing the site contractor acting as impartial judges of the efficiency of each means of odor control.

It was found that if the exposed garbage from the excavated landfill could be covered with about six inches of earth shortly after exposure the odors would be suppressed. Only the gases of decomposition would penetrate through the light covering of soil. This was further evidence that the odors were caused by the direct exposure of the odorous garbage to the atmosphere and not by the gases of decomposition, practically all of which are odorless.

Immediate covering with soil was not possible in most instances because great quantities of soil would have been required to blanket all of the exposed refuse at a construction site spread over more than 100 acres. Furthermore, shortages of materials for water lines, sewers and gas piping were such that frequently it was possible to install only one line when the trench was first opened. The result was that the trench had to remain open—with its sides as well as the excavated material exposing garbage in varying stages of decomposition—until the remaining lines could be installed.

To minimize these odors from exposed refuse it was necessary to resort to spraying all of the exposed surfaces. Various manufacturers of odor-control compounds were invited to recommend materials which they deemed suitable for this problem. All of the spraying was done with an orchard-type sprayer mounted on a 1½-ton truck as shown in the accompanying illustration. The sprayer consisted of a 300 gal. tank and a positive displacement pump with a capacity of about 10 gpm. at a pressure of 600 psi. A long hose delivered the spray solution to a short length of pipe held by the operator. An adjustable spray nozzle at the end of this pipe permitted the solution to be "fogged" or sprayed at the exposed refuse.

Among the chemicals recommended by manufacturers were organic disinfectants such as phenol and cresol coal-tar derivatives and amino compounds. These substances had phenol coefficients ranging from 3 to 6 and are widely used disinfectants. Results on landfills were not considered satisfactory because the characteristic odor of decaying garbage still persisted when the observers placed their nostrils close to the exposed refuse shortly after spraying.

Masking compounds were also tried, including those with a phenol

base and others with a pine-oil base. These substances have been used successfully to treat the interiors of buildings and ships in which odorous conditions existed. When used in high concentrations, the odor of pine oil and phenol can be made strong enough to be rendered insensitive to the nostrils and so mask the other more objectionable odors. In a closed space without much ventilation the odor of masking compounds will persist for a considerable period of time. However, when tried outdoors on exposed landfill refuse the masking odors persisted only a half hour or so with a light wind blowing. The tests indicated that at any reasonable dosage masking compounds were not effective for the control of odors on sanitary landfills.

Oxidizing agents effective

Oxidizing agents were then utilized on the theory that oxidation of the substances at the surface of the exposed organic matter would change its chemical characteristics and thus destroy the odorous substances. These tests proved highly successful.

Chloride of lime (ordinary commercial grade) was first dusted in the bottom of trenches by the workers laying utilities lines. Odors were controlled to a certain degree but the powder was difficult to disperse and could not be applied readily to the walls of the trenches. Futhermore, the powder had to be applied at a dosage sufficient to cover all of the refuse, requiring considerable quantities. All indications pointed to the need for a liquid that could be sprayed over the refuse.

Chlorinous solutions are excellent oxidizing agents but would be extremely corrosive to metals in the tank, pump and piping of conventional spraying equipment such as that previously described. Special equipment would have to be provided. This is usually not available on short notice when odor conditions arise at the site of a sanitary landfill.

In seeking a non-corrosive oxidizing agent for spraying the refuse, attention was paid to the experience of the Department of Sanitation of the City of New York in the removal of odors from the streets adjacent to the Fulton Fish Market. Considerable success had been obtained through the use of a solution of a chemical known as OD-30 which was sprinkled on the streets. It was found that this substance oxidized the thin film of organic matter that coated the streets and could not otherwise be removed by conventional methods of street cleaning.

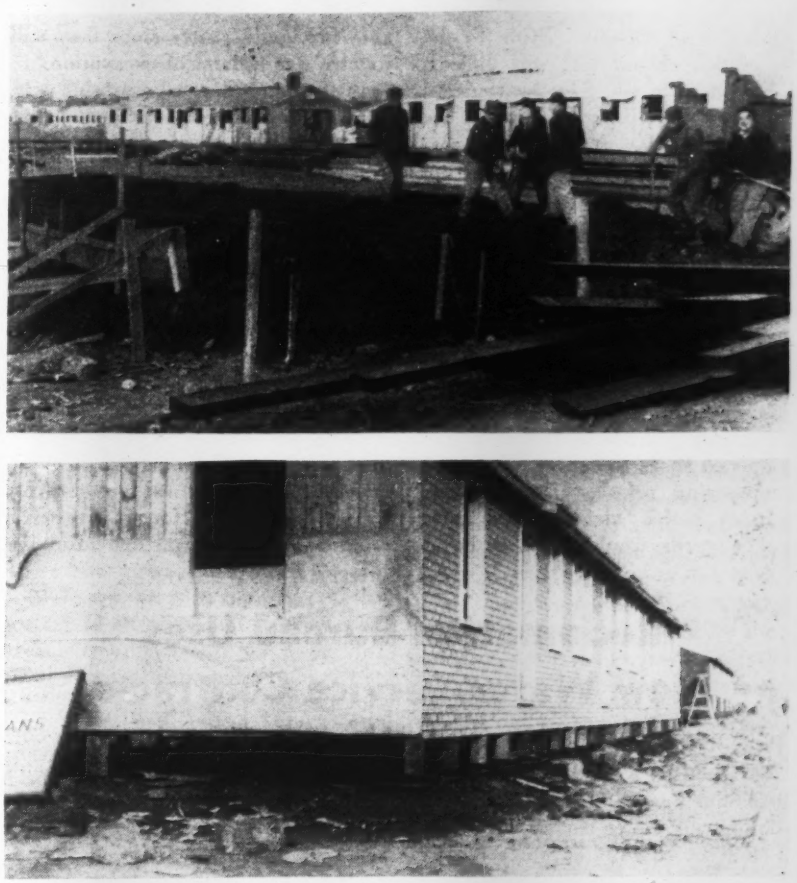


Fig. 3. To cope with the hazard of explosions resulting from the diffusion of methane gas through the fill, the houses were elevated to provide a ventilated air space. The top photo shows the placement of a 12-in. base of cinders on the fill where the houses are to be placed; the lower view shows the house in place, the under side of which is covered with an aluminum foil membrane.

Tests conducted at the Rego Park landfill showed that OD-30 could be used successfully to control odors from exposed refuse. This oxidizing agent is a proprietary substance, which was purchased by the city in powdered form from the OD Chemical Corp. of New York. For use on the landfill it was added to the tank of water and thoroughly mixed by the mixing device mounted on the truck. The solution was made up in a concentration ranging from $\frac{1}{2}$ to 1 percent. Depending on the quantity of garbage in the exposed refuse it was found that the necessary dosage of OD-30 ranged from 20 to 100 pounds per acre of exposed material.

The results of the tests indicated that one spraying was sufficient to control the odors if the surfaces of the refuse were thoroughly wetted by the spray. However, if rain followed the spraying in a day or two it was necessary to spray again. After that the oxidized substances dried out and odors were minimized. The operators of the spray truck learned to gauge their dosages by the appearance of the exposed refuse, depending chiefly upon ash content, and by returning to the site about an hour after spraying.

The success of the control of odors through the use of this oxidizing agent could best be judged by the reactions of the laborers working in the trenches. These men would call for the spraying crew on the slightest provocation and would work in the environment of the exposed refuse only after a thorough spraying with

a solution of OD-30. Prior to the use of this chemical it was difficult to hire men to work in the trenches that were cut through refuse in the sanitary landfill. It was noted also that complaints about odors from residents of the surrounding communities were greatly curtailed after proper spraying techniques were developed by the spraying crews.

Experience as a future guide

As a result of the experiences in constructing the Rego Park Houses it is apparent that sanitary landfills if it is at all possible should not be opened so as to expose any of the decomposing refuse. Developments such as parks, airfields and open storage yards would be most desirable for landfill sites since they will require a minimum of excavation.

If the landfill area must be used for a project that requires disturbance of the refuse underlying the two feet of protective earth cover, the guiding principles should be to keep the excavation at a minimum and to cover all exposed refuse as soon as possible with at least six inches of earth. Any refuse remaining exposed should be sprayed with an oxidizing agent to change the chemical characteristics of the exposed surfaces of putrescible organic matter. At Rego Park a solution of OD-30 proved highly successful when applied by means of an agricultural type sprayer.

The Rego Park Houses are being erected from excess wartime buildings by the Federal Public Housing Authority as part of the Veterans' Emergency Housing program. Preparation of the site, including grading of land and installation of underground utilities conduits was performed by Frank Mascali and Sons, contractors for the New York City Housing Authority.

When completed this project will provide temporary housing for the families of over 1,400 veterans. These houses will be owned and managed by the New York City Housing Authority of which Edmond B. Butler is chairman and Maxwell Tretter is executive director.

Comment on the limitations of landfill site use will be found on the editorial pages of this issue.

Reclamation Bureau Uses New Water-Service Contracts

To speed its work in the Missouri Basin, the Bureau of Reclamation is now offering water users a new type of contract combining water service and repayment agreements. The new type contracts have been drafted to provide the required flexibility to meet present day requirements of multiple-purpose reclamation works.

The contracts combine a water service charge and a construction repayment charge. They were developed after considerable study by the Bureau of Reclamation in conformance with provisions of the Flood Control Act of 1944, which authorized the Missouri Basin development, and the Reclamation Project Act of 1939. Construction has already commenced on four units of the multiple-purpose Missouri Basin project, and negotiations on the basis of the new contract have been started with water users on the Frenchman-Cambridge unit in Nebraska and the Heart River unit in North Dakota.

Under the act of 1939, costs of distribution systems constructed by the government must be repaid within 40 years. Water users must also pay for operation and maintenance of the distribution system. In the new-type contracts, farmers may elect to pay a fixed amount per year, or they may pay a variable rate which may change from year to year in accordance with actual farm income, being low in years of poor income and higher in years of good income.

In addition to contracting for repayment of the distribution system, water users will pay a water service charge, similar to the water charge of any public utility. This charge will be sufficient to maintain and operate the main water supply works and to return a part of the construction costs to the United States. The water service charges may vary from year to year as determined by such factors as farm income, amount of water used, or operating costs. The water service provisions of the contract likewise extend for 40 years. Continuation beyond the first 40-year period will generally be necessary to return to the United States the proper share of construction costs.

Shortly after announcing the new contract, officials of the Bureau of Reclamation revealed that the users of irrigation water, almost without exception are meeting their annual construction charges on time. This statement was made in releasing a report that includes data on 65 projects which will cost an estimated $1.8 billions when completed, including approximately $1 billion already expended by the federal government.

The report, which is entitled "Project Repayment Histories and Payment Schedules", states that $352,400,000 of U. S. funds will be repaid by the water users. An additional $473,000,000 of the irrigation investment will be returned from power revenues, while $546,000,000 invested in the power system will also be repaid from power revenues. The remaining costs of the bureau projects are allocated to flood control, navigation or other purposes not reimbursable under federal laws.

Water users on June 30 last had repaid a total of $74,800,000, which was 97.6 percent of the amount due under contracts in force at that time. Total net power revenues, some of which have assisted in meeting the payments due from water users, have amounted to nearly $39,000,000.

In addition to the construction charges which have been collected from irrigationists who are receiving water, $43,000,000 has been paid to the United States since 1907 for operation and maintenance of dams, reservoirs, and canal systems. A total of $15,000,000 has also been collected from project water users in water rental charges over the same period.

Full payments have been made for two dams: Laguna dam on the Yuma project, Arizona-California, and the Jackson Lake dam on Minidoka project, Idaho. Final payment for the Tieton Division of the Yakima project in Washington State was made the occassion of a celebration to be held in Yakima Feb. 14.

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Yellow Lights Advocated

Sir: In the issue of Oct. 31, 1946, vol. p. 580 I have been interested in the article by M. E. Mahan on "New Goals Set for Highway Lighting."

Referring to this, I would like to make the following remarks:

What reasons have been found for not having adopted in the United States the yellow light for the lights placed on automobiles? In France this type of lighting is obligatory because it is very much less glaring than the white light, because it decreases the number of accidents from night traffic, and statistics show, it would appear, that the proportion of night accidents in France is less than in the United States.

In addition, it seems that American automobile lights can be made better in ways that concern their placement to provide for reducing the glare.

Can you not consider these questions and communicate these remarks to interested parties in the United States?

A. ROBERT
Caluire, Rhone, France

More About "Sand-Islands"

Sir: Your recent mention of the "sand-island" method of bridge pier construction, *ENR* Feb. 6, vol. p. 213, prompts the submission of the following information. The Pamban Pass Bridge of the South Indian Railway's Indo-Ceylon Connection, between Mandapam on the mainland and Pamban on the Island of Rameswaram, was built 1911 to 1914. It had four piers constructed by means of the sand-island method, for supporting the two track-girder spans of a two-leaf rolling-lift bridge. Each of those piers comprised a pair of steel cylinders sunk through the sand islands to rock foundation, then sealed and filled with concrete, under the supervision of H. P. O'Shaughnessy.

The writer was resident engineer for the erection of the rolling-lift bridge, as an employee of the Scherzer Rolling Lift Bridge Co., Chicago, and utilized the two sand islands for temporary storage of erection equipment and bridge steel.

R. L. LARSON
Bridge Department, Division of Highways, Sacramento, California.

Stream Pollution Abatement

Sir: Your news statement of March 6, 1947, vol. p. 353, reporting on a meeting of the National Council for Stream Improvement, has been directed to my attention.

While I am not in a position to judge the accuracy with which the meeting is reported, I am certain that the article reflects an entirely erroneous impression of the present status of federal water-pollution bills.

In the first place, the discussion concerned "a bill introduced in Congress last year." The article also makes reference to a previous article in your magazine (*ENR* June 13, 1946, vol. p. 932) which is an excellent and accurate account of the situation at the time. The bill in question, however, died with the 79th Congress, and cannot be said to represent the "current move."

Those of us who have been active in the effort to abate pollution of the Ohio River have attempted to sponsor a bill that can be approved and supported by the federal, state and local organizations most vitally interested. We believe that we have that bill in the Spence-Elston-Taft-Barkley Measure (identical with HR-315, HR-470, S-418), usually referred to as the Spence bill. Organizations we place as having the greatest interest in this activity are the Conference of State Sanitary Engineers, the State and Territorial Health Officers Association, the American Water Works Association, and the Federation of Sewage Works Associations. The most recent actions of these organizations are deserving of study. These actions have been our guide.

The speakers referred to in the March 6, 1947 article are reported to "strongly advocate control of pollution through action by states, municipalities and industries concerned." The Spence bill attempts to use that approach. There is a deferred residual control clause in the bill inserted as a reasonable compromise measure on the understanding that a more nearly unanimous support of the bill would result. The bill, if anything, strengthens the position of states in pollution abatement activities, and the deferred residual federal control clause need be of little concern to the state making any effort at all in abating water pollution.

It is of interest to note that those supporting the Spence bill also support the Ohio Valley Water Sanitation Compact in the effort to solve interstate pollution problems by state authority while fully protecting the states against loss of any single constitutional right.

Your review of the question of federal water pollution bills of June 13, 1946, is praiseworthy. A similar review of the present situation would be most appropriate, not only to inform your readers of the current situation but to correct what I believe is an erroneous impression created by the subject article of this letter.

HUDSON BIERY
Chairman, Committee on Stream Sanitation
Chamber of Commerce
Cincinnati, Ohio

Mr. Biery appears to have misunderstood the purpose of the news item in question. It was simply a report of what was said at a meeting, not a report on the status of federal pollution-control bills.—EDITORS.

Correction

Sir: On vol. p. 352 of your March 6 issue, there is a condensation of a paper delivered by me before the North Atlantic Association of State Highway Officials. In connection with this, there is an error on the third line. The second sentence should read "A car requires a 6.1 second "hole" in passing traffic to cross a road". It will be noted that this figure was given as 61 seconds in the text.

DONALD SCHAPIRO
Bureau of Highway Traffic
Yale University, New Haven, Conn.

Book Notes and Reviews

The month's addition to the engineer's reading and reference list

Introduction to Arabia

SAUDI ARABIA—By K. S. Twitchell. 192 pp. Princeton University Press, Princeton, New Jersey. $2.50.

The increasing interest of American engineers and construction men in Saudi Arabia makes this a particularly useful book. Its author, an American mining engineer, writes, moreover, with authority and from personal knowledge gained in numerous investigations of the country's natural resources, made at the request of King ibn-Saud. As the King's advisor on economic development, he was privileged to travel in many sections of the country restricted to non-Moslems, and he records what he saw and learned in terms of its engineering significance.

Geography, geology, water supply, transportation, ports, cities and agriculture are discussed in the first section of the book. The second takes up the social and political history of the country, while a third is devoted to the position of Saudi Arabia in world economy, including its oil, mining and agriculture potentialities. For those wanting an introduction to Saudi Arabia, this is the best book available.

Sewage Plant Operation

MANUAL FOR SEWAGE PLANT OPERATORS—L. C. Billings, Editor-in-Chief. 435 pp. Texas Water Works and Sewerage Short School, Austin, Texas. $3.50.

Written by and for Texans and about Texas practice, this manual will nevertheless find a receptive audience over a much wider area. Twenty-nine authors, each an expert in the field he discusses, have pooled their efforts under the initiative and direction of the Sewerage Division of the Texas Water and Sewerage Short School to produce a thorough, down-to-earth text covering all phases of sewage works operation. This "engineered" work is aimed at the operator. It brings together and expresses "know-how" and experience simply and effectively. Every operator will find this book an indispensable source of guidance and instruction.

To one subject of increasing importance—"Industrial Waste Problems and Their Control"—30 pp. are devoted. This is, of course, but a short resume of a complex field, but its conciseness is supported by innumerable references to parallel literature. The reports, articles and books listed will assist interested parties in the pursuit of their studies.

Another chapter, "Mathematical Problems Connected with Sewage Treatment and Disposal," discusses measurements pertaining to flow, pump efficiences, trickling filter loadings, sludge quantities, and chemical treatment. The operator will find this material helpful.

The final chapter covers Texas standards for design, operation and reporting of sewage treatment plants.

Miscellaneous Notes on Booklets and Reprints

MILITARY RAILWAY BRIDGES developed during World War II are described in a pamphlet entitled "Standard Military Railway Bridges" which has been published by the *Railway Gazette*, London, S. W. 1, England. The booklet is a reprint of five articles by F. S. Bond published in the *Railway Gazette* Four of the articles relate to British practice and the fifth describes American practice briefly. The price of the pamphlet is 5 shillings.

INFORMATION relating to state restrictions on motor vehicle size and weight, registration fees and equipment requirements, heretofore published by the National Highway Users Conference (National Press Building, Washington 4, D. C.) in pamphlet form is now to be published in loose leaf form in view of the fact that much of this information becomes obsolete quite rapidly. Subscribers to the new service will receive notice of every law change as soon as it has been made in each of the 48 states.

STANDARDS ON CONCRETE AND CONCRETE AGGREGATES promulgated by the American Society for Testing Materials are presented in a compact form in a 160-page book with heavy paper cover, obtainable from ASTM, 1916 Race St., Philadelphia 3, Pa., for $2. Included in this second edition are specifications, methods of testing and definitions, covering cement, aggregate, reinforcement, preformed expansion joint fillers, sieves, curing materials and air content.

THE DATE OF PUBLICATION or the date of latest revision of all books published by the McGraw-Hill Book Company now is given in the listings of those books in the company's catalog for 1947, which is available from the company's office at 330 West 42nd St., New York 18, N. Y.

New Engineering Books

ENGINEERING PROBLEMS MANUAL—New Fourth Edition. By F. C. Dana & L. R. Hillyard. 419 pp. McGraw-Hill Book Co., New York 18, and London. $3.25.

ECONOMIC POLICY AND FULL EMPLOYMENT—By Alvin H. Hansen. 340 pp. McGraw-Hill Book Co., New York, and London. $4.

THE STORY OF WATER SUPPLY—By F. W. Robins. 207 pp. Oxford University Press, 114 Fifth Avenue, New York 11. $5.50.

PUBLIC WORKS ENGINEERS' YEARBOOK—1946 Directory—American Public Works Association., Chicago, Ill. 252 pp.

RUSSIAN-ENGLISH TECHNICAL & CHEMICAL DICTIONARY—By L. I. Callaham. 794 pp. John Wiley & Sons, New York 16; Chapman & Hall, London. $10.

SEWERAGE & SEWAGE TREATMENT—6th Edition—By Harold E. Babbitt. 692 pp. John Wiley & Sons, New York 16; Chapman & Hall, London. $6.50.

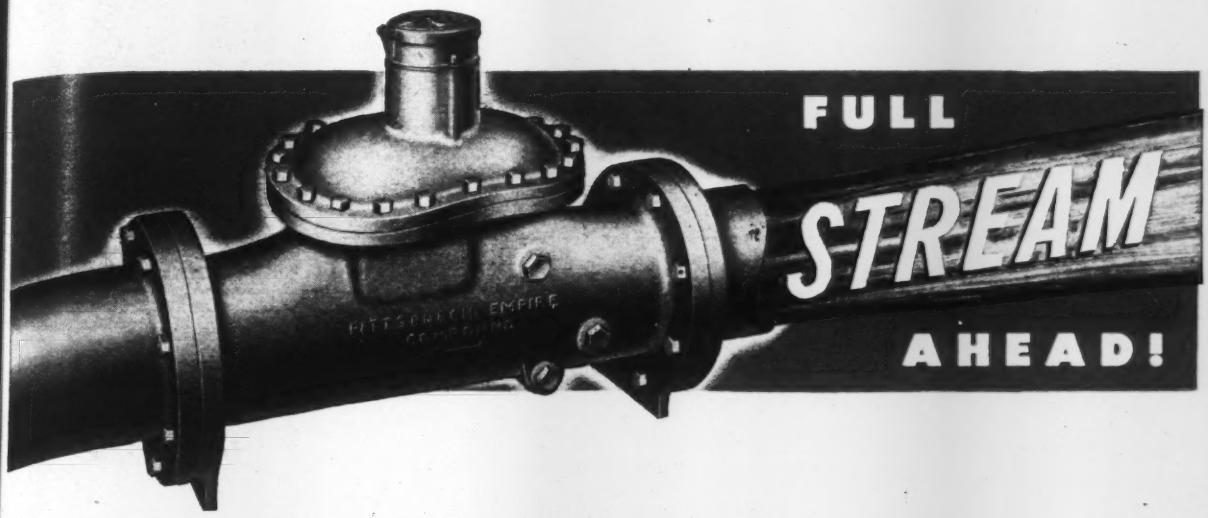
INTRODUCTION TO AERODYNAMICS OF A COMPRESSIBLE FLUID—By H. W. Liepmann & A. E. Puckett. 262 pp. John Wiley & Sons, New York 16; Chapman & Hall, London. $4.

HOUSE OUT OF FACTORY—By J. Gloag and Grey Wornum. 192 pp. George Allen & Unwin, Ltd., London; The MacMillan Co., New York. $3.

APPLIED ENGINEERING MECHANICS—By Alfred Jensen. 316 pp. McGraw-Hill Book Co., New York 18, and London. $3.

SOIL CONSERVATION—By Hugh H. Bennett. 993 pp. McGraw-Hill Book Co., New York 18, and London. $6.50.

(*Continued on page* 129)



NO BRAKES ON LINES FITTED WITH PITTSBURGH - EMPIRE *Compounds*

The Pittsburgh-Empire Compound largely eliminates the pressure loss bottleneck that has previously been a trial on lines fitted with compound meters. Alone among meters of this type, the Pittsburgh-Empire has a straight through flow passage for all volumes measured by the propeller unit. (See diagrams below).

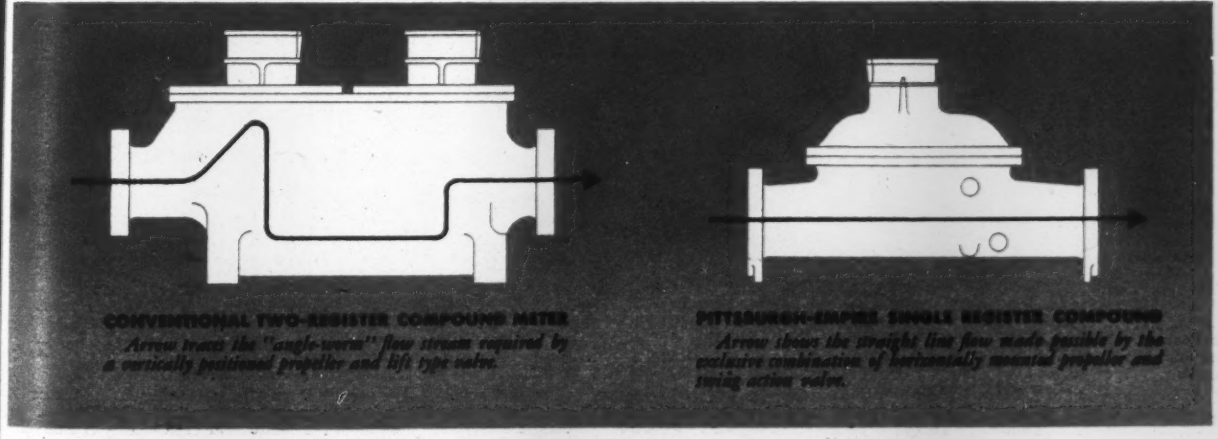
Two design features make possible minimum pressure absorption. (1) The propeller is horizontally mounted on roller bearings to freely rotate in the direct path of the incoming stream. (2) A counter balanced swing action valve, located immediately behind the propeller, pivots upward to full open position where it offers negligible resistance to the flow. In all sizes propeller cage and valve orifice diameters are at least equal to actual pipe size. Accordingly, large volume flows are handled with dispatch and without change of direction of the flow. Turbulence is also overcome. This meter operates quietly.

Now is a good time to check all the features of the lightweight, compact, single register Pittsburgh-Empire Compound. To get the full facts write your nearest sales office for a copy of bulletin W-803.

PITTSBURGH EQUITABLE METER DIVISION

Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Atlanta Boston Chicago Houston Kansas City Los Angeles
New York Pittsburgh San Francisco Seattle Tulsa



CONVENTIONAL TWO-REGISTER COMPOUND METER
Arrow traces the "angle-worm" flow stream required by a vertically positioned propeller and lift type valve.

PITTSBURGH-EMPIRE SINGLE REGISTER COMPOUND
Arrow shows the straight line flow made possible by the exclusive combination of horizontally mounted propeller and swing action valve.

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

CEMENT, AGGREGATE, READY-MIXED CONCRETE—F. O. B. CITY

	PORTLAND CEMENT (Per bbl. C/L lots incl. $1.00 per bbl. for bags, cash dis. not deducted)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE BLOCK (8x8x16-in.; truckload del.; per block)	READY MIXED CONCRETE (1:2:4, over 8 sack, del.; per c.y.)	
	Cloth	Paper	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	Sand grav.	Lt.wgt. Agg.	50 c.y. del.
Atlanta	$3.62	$2.77	$2.52	$1.79	$1.89	$1.65	$1.79	$1.89	$1.59	$1.69	$0.1725	....	$9.00
Baltimore	3.46	2.61	2.36	2.10‡	2.10‡	1.60‡	2.20‡	2.20‡	2.20‡	2.20‡	.145	$0.145*w*	8.35
Birmingham	3.65	2.80	....	2.06	2.06	1.63	2.50	2.50	1.00	1.20	.1425	.1425	6.95
Boston	3.88*bnn*	3.03*bnn*	2.78*bnn*	1.50‡	1.50‡	1.40‡	1.25	1.35	....	....	.13	.155*w*	7.90*m*
Chicago	3.85	3.00	2.75	2.50‡*d*	2.50‡*d*	2.75‡*d*	2.50‡*d*	2.50‡*d*	2.00‡	2.00‡	.195	.195*x*	....
Cincinnati	....	....	....	....	....	....	....	....	....	....	....	....	....
Cleveland	3.47	2.62	....	2.50‡	2.50‡	1.15‡‡	3.20‡*qq*	3.20‡	2.40	2.40	....	19	10.15
Dallas	3.32	2.47	2.22	1.80	1.80	1.60	1.89	1.99	....	....	.0775*p*	....	8.68
Denver	3.93	3.08	2.83	1.85	2.00	1.15	....	....	....	....	....	.2175*w*	9.00
Detroit	3.40	2.55	2.30	2.75	2.75	2.50	2.50	2.50	2.50‡	2.50‡	.16	.17*w*	8.30*kk*
Kansas City	....	3.00	....	2.00	....	1.40	2.00	2.00	....	....	.16	.16*wy*	8.50*n*
Los Angeles	....	....	....	1.55	1.55	1.40	1.40*f*	1.40*f*	1.40*f*	1.40*f*	.125*bb*	.14*bb*	8.75*m*
Minneapolis	4.25‡*dd*	3.40*dd*‡	....	1.90*h*‡	1.90*h*‡	1.00*h*‡	1.90*h*‡	1.90*h*‡	....	....	.183*ff*	....	9.05*jkk*
Montreal	.....	2.05*r*	1.90*r*	1.78*ts*	1.78*ts*	1.10*t*	.95*ct*	1.05*ct*	....	....	.1391	.1515	7.75*tt*
New Orleans	3.28*rr*	2.43	2.18	1.82	1.82	1.62	....	....	.90	1.15	.23	....	9.92
New York	4.36‡	3.36‡	....	1.80*deu*	1.80*deu*	1.15*eee*	1.90*de*	1.90*de*	....	....	.20*ii*	.18*wcii*	9.15*k*
Philadelphia	....	3.20‡	2.32	1.55‡	1.65‡	1.25‡	1.90‡	1.95‡	1.50	1.50	.155	.155*w*	8.80
Pittsburgh	....	2.51*oo*	2.26*pp*	1.85‡	1.85‡	2.15‡	2.35‡	2.35‡	1.80	1.80	.21*z*	.21*z*	9.85
St. Louis	3.52*mm*	2.67*omm*	....	2.10‡*o*	2.10‡*o*	2.10‡*o*	1.25/1.95	1.25/1.95	....	....	.175	.22*yo*	9.45
San Francisco	3.54*jj*	2.64	2.24	1.56	1.56	1.66	1.66	....	....	....	....	.25*y*	9.05
Seattle	....	3.10*b*	....	2.50*d*‡*o*	2.50*d*‡*o*	2.50*d*‡*o*	3.00‡*od*	3.00‡*od*	....	....	.18	....	8.80

‡ Delivered. *b* 10c. per bbl. off for cash. *c* F.o.b. quarry. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.d. Granite City, Ill. *h* Truck Lots. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount of 2 percent for cash in 10 days. *l* 2000 lb. concrete. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 5½ x 8 12 in. *q* 5 cu. yds. or more. *r* 10% per bbl. off cash 20 days. *s* 8% sales tax included. *t* 8% sales tax not included. *u* In outlying New York districts, price is $1.89. *v* 80c. per bbl. for bags. *w* Cinder. *x* Waylite. *y* Haydite. *z* Celocrete. *aa* Pumice. *bb* 4 x 8 x 12 in. *cc* Also 8 x 18 in. *dd* Prices quoted are LCL. Carload lots not available. *ee* In outlying New York districts, price is $1.22. *ff* 8 x 8 x 18 in. *ii* Yard price. *kk* 2500 lb. compression strength. *jj* $.30 refund for each returnable bag. *ll* Price at plant.

Corrections. mm CL, f.o.b. city cloth price was $3.52 for Apr.; paper price was $2.67. Prices quoted last month were for truck, del. *nn* Mar., Apr. prices were at May level. *oo* Price has been $2.51 since Jan., 1947. *pp* Price has been $2.26 since Jan., 1947. *qq* Price has been $3.20 since Feb., 1947. *rr* Price has been $3.28 since Mar., 1947.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount. 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c. per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICE BASES AT CEMENT MILL

Charge for bags not included. For cloth bags, add $1.00. per bbl.; 25c. refund allowed for each returnable bag; for paper bags add 20c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind.	$2.00	$1.95	Ironton, Ohio	$1.95*	$1.90*	Universal, Pa.	$2.00	$1.95
Hannibal, Mo.	2.00	1.95	Northampton, Pa	1.90	1.85	Waco, Tex. (Plus 9c. tax in Tex.)	1.85	1.80
Independence, Kans.	2.00	1.95	Richard City, Tenn	2.00	1.95	Montreal City (Discount 10c. per bbl. 20 days)	1.78	1.78
			Steelton, Minn.	2.10	2.05			

* Destination price base effective Sept. 17, 1945

PAVING BRICK, BLOCK, ASPHALT, ROAD OILS—F. O. B. CITY

	PAVING BRICK AND BLOCK			PAVING ASPHALT (Per ton, less than 80 penetration)		ASPHALT BINDERS—FLUXES (Per gal., 80–300 penetration)		CUTBACK ASPHALT (Per ton)		ROAD OIL (Per gal.)	ASPHALT EMULSION (Quick-breaking) (Per gal.)	
	Granite per M lots of 50,000 4x4x8 in.	Brick per M 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$73.00	$35.00	$2.25	$14.00	.....	$0.074	.....	$0.0806*h*	.....	$0.0781	$0.0806	.....
Baltimore	160.00‡	60.50	95.00*m*	16.00*r*	25.00*r*	.075*r*	0.11*r*	15.00*r*	25.00*r*	.075*r*	.085*r*	.15*r*
Birmingham	.....	32.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Boston	85.00	59.00	3.75	16.00	25.00	.0675	.12	18.00	31.00	.0675	.0875	.15
Chicago	150.00‡	65.00/68.00*e*‡	2.97/4.10*d*‡	17.00/18.00*b*	25.00/25.50*b*	15.50*bg*	24.00/24.50*bg*	.0775/.085*bh*	.1625/.165*bh*	.0625/.0655*b*	.0925/.1025*b*	.14/.165*b*
Cincinnati	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cleveland	150.00	49.00*t*	3.43*g*	18.00	26.00	17.00*g*	25.00*g*	.085*h*	.17*h*	...	.105	.20
Dallas	.....	40.00	.....	16.95	29.15	.0686	.1225	20.00	37.60	.06	.0725	.135
Denver	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	75.00*t*	.....	20.00*f*	26.00*f*	18.40*g*	24.40*g*	.0811*h*	.128*h*	.075	.1085	.1822
Kansas City	.....	40.00	.....	17.00	24.00	16.00*g*	23.00	.08*h*	.13*h*	.....	.12	.16
Los Angeles	.....	60.00	.....	9.50*b*	24.00*b*	10.00*bg*	24.50*bg*	10.00*b*	.....	.04*b*	.10*b*	.20*b*
Minneapolis	.....	.....	2.39*d*	.....	.....	.....	.....	.....	.....	.....	.....	.....
Montreal	.....	.....	.....	16.60*k*	24.25*k*	.1160*k*	.1485*k*	.115*hk*	.135*hk*	.08*k*	.1354	.1884
New Orleans	.....	.....	.....	13.50*a*	.....*s*	12.50*g*	.....*s*	6.75	.....*s*	.055	.08	.13
New York	.....	.....	2.60*n*	20.68	32.85*s*	19.68*g*	38.68*g*	.0857*h*	.1669*h*	.0807	.0855	.1643
Philadelphia	150.00	62.00	4.06	19.00	.....	17.00	.....	.08*h*	.....	.....	14.00*pr*	.....
Pittsburgh	135.00	39.75	3.90	19.00	27.00	.095	.135	22.00	34.00	.075	.085	.15
St. Louis	.....	42.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
San Francisco	.....	47.75*c*	.....	11.75	25.25*w*	11.75*g*	.....	13.75	.....	.....	.0525	.1225
Seattle	.....	.....	.....	11.75*i*	22.75*i*	9.50	.....	12.25*i*	15.25	10.90*i*	.0525*i*	.0625

‡ Delivered. *a* F.o.b. Baton Rouge. *b* F.o.b. Refinery. *c* 2½ x 8½ x 4 in. *d* 2-in. interior block, 6-lb. treatment. *e* 3½ x 4 x 8½. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3 x 3½ x 8½ in. *k* Tax included. *l* Quoted on request only. *m* Per thousand. *n* 2 in., treatment 6 lb. *r* February 1943 prices, none later available. *s* Drums not available. *t* Truck deliveries in Greater Cleveland. *w* Shipped in double head wood barrels. *v* 3 in. block.

Double shock shields made of nylon now give you more for your tire dollar

USERS of the B. F. Goodrich Universal (shown above) and other B. F. Goodrich off-the-road tires have long reported greater savings because of shock shield construction — B. F. Goodrich's answer to the problem of impact bruises when tires strike rocks, ruts, timbers, etc.

Now, shock shields . . . made of *nylon* . . . are used in all large B. F. Goodrich off-the-road tires. These double nylon shock shields consist of four layers of nylon cords between the tread and the plies. The nylon layers are in pairs — cords in each pair running at scientifically determined angles with those in the other pair to give "balanced" strength.

The strong, elastic nylon cords in each layer run parallel, fully insulated in live rubber. Under impact the cords in the shields stretch together, not across each other, and return to their original position. Because of this principle, impacts are *distributed,* absorbed . . . the rayon cord body is actually *shielded from shock!*

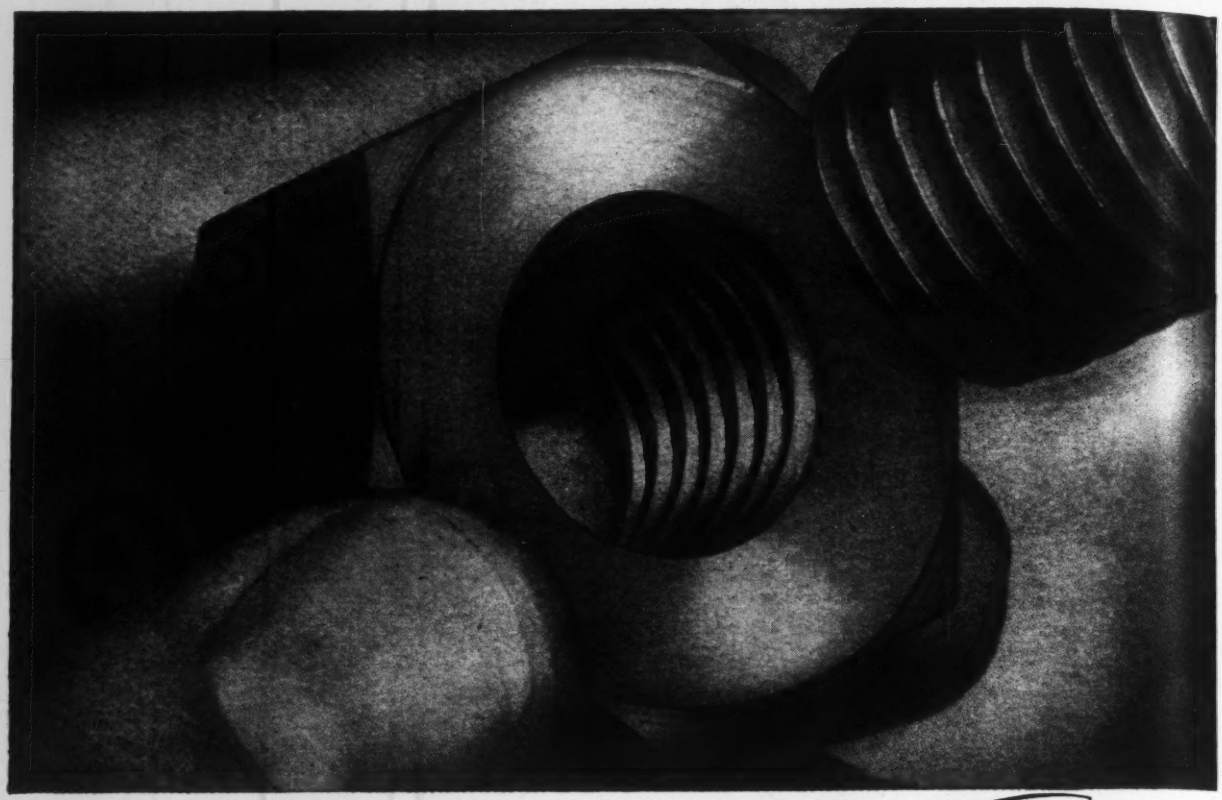
No make of tire other than B. F. Goodrich gives you the added protection of the *double nylon shock shield* . . . the additional saving through: (1) longer tire life; (2) increased number of recappable tires; (3) increased bruise resistance; and (4) less danger of tread separation.

Too, there are extra advantages with B. F. Goodrich Universal Silvertowns. The tread is non-directional. Spares can be mounted on any wheel position. The Universal's tread has thick, heavy lugs that protect the undertread. And the tread is designed so that the natural running action pushes mud and dirt toward the edges. The tire stays *clean;* gives excellent traction in *either* direction and resists side slippage.

Find out how B. F. Goodrich can help you solve your tire problems. See the B. F. Goodrich dealer or write us direct. *The B. F. Goodrich Company, Akron, Ohio.*

Truck Tires BY

B. F. Goodrich



WHEN YOU LOWER THE COST OF USING FASTENERS . . . THAT'S t.f.e.

True Fastener Economy!

Since the time and labor costs of assembly usually exceed the cost of the fasteners, it's *T*rue *F*astener *E*conomy to buy the *type* and *brand* of fastener that gives maximum speed and convenience in assembly.

RB & W *Nuts Save Assembly Time*

The care which RB&W takes to produce nuts with utmost accuracy and uniformity . . . pays off in terms of lower assembly cost. Careful selection of material; cold-punching that insures toughness, freedom from splitting, uniformity of size; repunching that guarantees concentricity of hole; burnishing that assures smoothness of all surfaces; tapping on machines of special design that provide accurate, clean threads . . . result in nuts that run on quickly and take severe wrenching in their stride.

You Get T. F. E. *When You*

1. Reduce building time to a minimum by savings through use of quick-assembling bolts and nuts
2. Make your men happier by giving them fasteners that make their work easier and safer
3. Reduce the number and size of fasteners by proper design
4. Use the fastening method—bolts and nuts—which involves minimum indirect labor, noise and confusion
5. Purchase maximum holding power by capitalizing upon the high residual tension set up by bolt-and-nut fastening
6. Simplify inventories by standardizing on fewer types and sizes of fasteners
7. Save purchasing time by buying larger quantities from one supplier's complete line
8. Assure yourself of satisfactory fastener performance by using a source of supply with a reputation for dependability

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

102 years making strong the things that make America strong

RB&W bolts, nuts, screws, rivets and allied fastening products are manufactured in a broad range of styles, sizes and finishes.

• • •

Plants at: Port Chester, N. Y., Corsopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at: Philadelphia, Detroit, Chicago, Chattanooga, Portland, Seattle. Distributors from coast to coast. By ordering through your distributor, you can get prompt service from his stocks for your normal needs. Also—the industry's most complete, easiest-to-use catalog.

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS billet *b*	RIVETS ½-in. structural	WIRE NAILS Based	SHEET PILING Base	STEEL RAILS Per Net Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.50	$2.45	$5.25	$3.75/4.50	....	$50.00	$57.00	Not	$3.00	$3.65/4.50	$2.80	$6.50
Chicago	2.50	2.45	5.25	3.75/4.50	$3.00	.....	.....	avail-	3.00	3.65/4.50	2.80	6.50
Pittsburgh	2.50	2.45	5.25	3.75/4.50	3.00	50.00	57.00	able	3.00	3.65/4.50	2.80	6.50
Buffalo	2.50	2.45	....	....	3.00	.....	.....	.....	....	....	2.80	....
Cleveland	....	2.45	5.25	3.85	....	.....	.....	.....	....	....	....	....
Youngstown	....	2.45	.....	....	....	.....	.....	.....	....	3.65/4.50	....	....
Detroit	....	.....	.....	....	....	.....	.....	.....	....	....	....	....
Gulf ports	....	.....	.....	....	....	.....	.....	.....	....	....	....	....
Geneva	2.675‡	.....	.....	....	....	.....	.....	.....	....	....	....	....
Los Angeles	3.17/3.41‡	3.025‡	....	....	....	.....	.....	.....	....	....	....	....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone. Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per cl. *e* Mill lengths. Add $ .50 for cut lengths.

IRON AND STEEL PRODUCTS—F. O. B. WAREHOUSE, PER 100 LBS., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb base price	REINFORCING BARS *g* Per 100 lb., base prices 5 tons to carload lot *b* New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH Per 100 sq. yd., carload lots Std. diamond mesh, 3.4 lb	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 sq. ft., carload lots 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per 100 s. f.	SHEET PILING Per 100 lb base price
Atlanta	$4.05‡	$4.12‡	$4.12‡	$.025	$.10	$23.16	$25.30	$2.00	$1.50	$2.12	$3.35
Baltimore	4.25	3.635	....	....	.10	29.00	31.00	1.88	1.42	2.00	3.25
Birmingham	2.50*a*	2.45*a*	2.45*a*	.05	.10	37.50*p*	40.50*p*	1.98	1.49	2.10	....
Boston	4.162‡	4.194‡	2.97*c*	$20 C.L.	.10	18.50	20.50	1.94	1.46	2.05	3.02
Chicago	4.05	3.80	2.60/2.95*a*	.05	.05	24.00‡	26.00	1.85	1.40	1.96	3.00
Cincinnati	....	.. .	....	....	....	.....	.....	1.87	1.41	1.96	....
Cleveland	4.311	3.40*v*	....	.025	.10	26.00	28.00	1.84	1.40	1.95	....
Dallas	6.00	5.00	5.00	....	....	31.00	35.00	2.11	1.57	2.22	....
Denver	5.50	4.97*c*	....	....	....	36.00	41.00*q*	2.15	1.60	2.28	....
Detroit	4.42‡	3.591‡	3.591‡	....	.10	38.00‡	42.00‡	1.86	1.41	1.97	3.31
Kansas City	4.85	2.95*cd*	2.80*cd*	.0	.05	30.00	32.00	1.96	1.48	2.08	3.0826*a*
Los Angeles	5.20*f*	3.025	2.875	.03	.05	23.00	27.50	2.11	1.57	2.24	5.20
Minneapolis	4.434‡	3.965	3.69	.0	.10	26.50	28.50	1.98	1.49	2.10	3.47*d*
Montreal	4.55*i*	4.20*i*	4.20*i*	....	....	36.00*hi*	38.70*hi*	2.87	3.54*i*	2.96*im*	73.00*id*
New Orleans	4.408‡	4.18*o*	....	.05	.10	27.50	29.50	2.00	1.50	2.12	3.125
New York	4.17*r*	3.85	. ..	....	.10/.15	30.50*st*	32.505*st*	1.97	1.44	2.19	3.00
Philadelphia	3.97	4.24	....	....	....	22.50‡	24.75‡	1.89	1.43	2.00	3.41
Pittsburgh	3.80	3.20	3.20	.05	.10	23.00	26.80	1.77	1.35	1.88	3.00
St Louis	3.93	3.49	3.49	.0	.05	34.00	36.00	1.87	1.42	1.97	....
San Francisco	4.90	3.83	2.875	.025	.10	28.00	31.50	2.11	1.57	2.24	4.50
Seattle	3.368*e*	3.368*e*	....	....	....	43.00	44.00	2.11	1.57	2.24	4.37*e*

‡ Delivered. *a* Mill prices. *b* 1–5 tons, add 35c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. customer's spur. *f* Includes delivery in free delivery zone. *g* High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills. *h* List price. *i* Plus Dominion and Province sales tax. *j* Price per ton. *m* Per sq. yd. *n* Practically no carloads are available. Retail price delivered is $27.00 for std. diamond mesh and $29.00 for std. ribbed. *o* 5 to 15 tons Base. *p* Deliveries of 5000 sq. yd. or less. *q* ⅜ in. standard ribbed. *r* 5 tons or over. *s* LCL. *t* Asphalt coated. *u* Note: Revised size extras—¾ in. and over $.15, ⅝ in. $.20, ½ in. $.30, ¾ in. $.50, ¼ in. $1.20. *v* $2.99 for 25 tons and over.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in. *a*	VITRIFIED SEWER PIPE Per foot, Delivered std. 8 in. s.s.	std. 12 in. s.s.	24 in.	36 in.	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in	8 in	CONCRETE SEWER PIPE Per ft., delivered: ASTM 12 in.	C 14–41 24 in	WROUGHT STEEL PIPE (Full standard weight, f.o.b. destination *s*) 1 to 3 in., Butt Weld Black %	Galv %	3½ to 6 in., Lap Weld Black %	Galv. %
Atlanta	$76.28	$0.43	$0.67	$3.39	....	$114.00	$140.00	$0.45	$2.00	53.2	40.2	50.7	37.2
Baltimore	80.60	.35	.60	2.70	$7.25	160.00	200.00	.85	2.25	56.9	43.9	54.4	40.9
Birmingham	71.00	.375	.675	3.06	....	210.00‡	375.00‡	.75	2.00	53.2	40.2	50.7	37.2
Boston	83.20	.392*m*	.756*m*	3.15*m*	7.995*m*	170.00‡*m*	265.00‡*m*	.53*h*	2.04*h*	55.2	42.2	52.7	39.2
Chicago	81.56	.49	.95	3.60	....	200.00‡	270.00‡	.65	2.25	59.0*t*	46.0*t*	55.5*t*	42.0*t*
Cincinnati	80.36	....	....	...	....	.....	.....	.54	2.00	57.4	44.4	54.9	41.4
Cleveland	82.04	.308	.594	2.655	7.0725	112.00*p*	176.00*p*	.58	2.25	59.65	46.65	57.15	43.65
Dallas	83.78	.375	.675	2.70	6.20	109.00	131.00	.45	1.45	51.3	38.3	48.8	35.3
Denver	88.62	.38	.68	2.84	....	154.00	295.00	.64	2.25	49.4	36.4	46.7	33.2
Detroit	82.04	.455	.8775	3.69	8.50*l*	170.00‡*m*	263.00‡	.50	1.90	57.9	44.9	55.4	41.9
Kansas City	83.12	.345	.625	2.48	7.00	175.00	312.00*m*	.50	1.70	54.7	41.7	51.8	38.3
Los Angeles	95.00	.414†	.745†	2.988	7.47	157.00	260.00	1.25	2.50	....	....	....	....
Minneapolis	85.10	.51†*o*	.98†*o*	3.95†*o*	....	.....	.....	1.04*h*	2.67*h*	54.8	41.8	51.9	38.4
Montreal	78.20	.68	1.20	3.94	6.38*e*	.48	.68*p*	72.00*jk*	218.00*jk*	....	....	....	....
New Orleans	78.68	.40	.72	3.06	....	.....	.....	.55	1.95	52.8	39.8	50.3	36.8
New York	79.80	.52	1.01	4.00	9.43	.....	.....	.60*h*	1.85	56.2	43.2	53.7	40.2
Philadelphia	78.20	.50	.95	3.95	9.75	220.00	275.00	.90*h*	2.75*h*	56.7	43.7	54.2	40.7
Pittsburgh	82.52	.322†*m*	.631†*m*	2.70†*m*	6.625*m*	124.20	193.90	1.05*h*	2.50*gh*	60.0*t*	47.0*t*	57.5*t*	44.0*t*
St Louis	79.88	.351*n*	.632*n*	2.527*n*	5.60*n*	105.80	212.00	1.20*h*	2.55*h*	56.6	43.6	53.2	39.7
San Francisco	95.00	.4375*d*	.7875*d*	3.15	7.875	159.00	265.00	.69	2.85	....	....	....	....
Seattle	96.80	.45*b*	.81*b*	....	....	.....	.....	.595*f*	1.98*f*	....	....	....	....

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, Burlington, N. J. (base) $70.00. Based on existing freight rates; subject to rate change. Gas pipe and class A, $5 per ton additional. 4 in., $5 per ton additional, 30 in. and larger, usually $1 per ton less. *b* Double strength. *d* List. *e* 30 in. *f* Less 2% for cash. *g* Culvert pipe. *h* Reinforced. *j* Centri-spun. *k* Per 100 feet. *m* Truck delivery. *n* Less 3% for cash. *o* Since carload lots are not available at this time, listed price is based on LCL (no minimum). *p* Less than 5 ton loads, price per foot. 5% discount 10th of month following. *s* Discounts from standard list consumers carload prices. Base price approx $200 per net ton. List prices per ft.: ¼ in., 8½c.; ⅜ in., 11½c.; 1 in., 17c.; 2 in. 37c.; 2½ in., 58½c; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92; 3 percent tax on transportation costs not included. *t* Within switching limits. WROUGHT IRON PIPE: List prices per ft. same as wrought steel pipe. Discount for Pittsburgh base. Buttweld — 1 in. and 1¼ in. black, 34, galv., 16; 1½ in. black, 38, galv., 18½; 2 in. black, 37½, galv., 18. Lapweld — 2½ in. to 3½ in. black, 31½, galv., 14½; 4½ in. to 8 in. black, 32½, galv., 17. Freight rates to destination to be added to name delivered price.

LUMBER, TIMBER, PLYWOOD—PER M FT., B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) *All Fir planks No. 2 common, Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)*									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	1x6 S4S	1x8 S4S	2x4 S4S	2x6 S4S	2x8 S4S	2x10 S4S	3x12 Rgh	6x12 Rgh	12x12 Rgh	2x12 Rgh	12x12 Rgh	¼"	¾"
Atlanta	$70.00	$70.00	$65.00	$65.00	$65.00	$65.00	$88.50	.....	.....	$86.00	$86.00	$17.72	$21.57
	90.00	90.00	88.50	88.50	87.50	87.50	81.00	$80.50	$79.50	.....	.....	.....	.....
Baltimore	78.00	80.00	80.00	78.00	82.00	86.00	95.00	.....	.....	160.00	150.00	18.45	21.995
	88.00	90.00	93.00	92.00	94.00	94.00	100.00	100.00	100.00	.....	.....	.....	.....
Birmingham	87.50	87.50	87.00	86.00	87.00	90.00	110.00	.....	.....	110.00	112.50	17.245	20.795
[1]	92.50	92.50	92.00	91.00	92.00	95.00	114.00	97.00	98.00	.....	.....	.....	.....
Boston	70.00[3]	72.00[3]	66.50[3]	62.50[3]	70.50[3]	74.50[3]	70.25[3]	.....	.....	.....	.....	18.195	21.995
	64.75	64.75	62.75	63.25	62.75	62.75	60.50	59.50	59.50	59.50	.....	.....	.....
Chicago	‡ 100.00	100.00	95.00	95.00	95.00	98.00	98.00	.....	.....	125.00	125.00	14.555	17.555
	‡ 100.00	100.00	95.00	95.00	95.00	98.00	95.00	95.00	95.00	.....	.....	.....	.....
Cincinnati	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17.245	20.795
Cleveland	k 100.00	100.00	100.00	100.00	100.00	105.00	.....	.....	.....	130.00	150.00	17.615	21.265
	k 115.00	115.00	115.00	115.00	115.00	120.00	135.00	135.00	140.00	.....	.....	.....	.....
Dallas	89.00	89.00	86.75	87.75	89.00	61.50	61.00	.....	.....	94.75	91.00	14.555	17.555
Denver	93.50	93.50	97.00	97.00	95.50	96.50	.....	.....	.....	.....	.....	10 .285	12.435
Detroit	90.00	90.00	87.00	87.00	87.00	93.00	100.00	.....	.....	95.00	110.00	17 .245	20.795
	98.00	98.00	96.00	97.00	97.00	100.00	105.00	105.00	110.00	.....	.....	.....	.....
Kansas City	a 86.00	86.00	84.00	82.75	83.25	86.00	105.00	.....	.....	105.00	110.00	12.605	15.205
	88.00	88.00	87.50	87.50	85.50	87.00	85.00	105.00	105.00	.....	.....	.....	.....
Los Angeles	a 78.50	78.50	79.50	80.00	78.50	78.50	91.00	91.00	80.00	.....	.....	9.81g[h]	11.86g[h]
Minneapolis	‡ 102.00[4]	102.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.765	16.615
	‡ 103.00	103.00	100.00	100.00	100.00	103.00	125.00	125.00	125.00	.....	.....	.....	.....
Montreal	e[7] 69.00	70.00	64.00	68.00	70.00	75.00	.20[i]	.....	.....	.20[i]	.20[i]	.....	.....
	97.00	97.00	97.00	97.00	97.00	97.00	87.00	87.00	87.00	.....	.....	.....	.....
New Orleans	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.555	17.555
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
New York	‡ 92.50	92.50	92.50	92.50	92.50	92.50	$115.00	.....	.....	.....	.....	18.195	21.995
	‡	.....	97.50	97.50	97.50	97.50	Range from $110 to $125			.....	.....	.....	.....
Philadelphia	110.00	110.00	110.00	110.00	110.00	110.00	110.00	.....	.....	150.00	150.00	18.195	21.995
	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	.....	.....	.....	.....
Pittsburgh	59.40	61.80	71.35	63.60	69.45	73.10	84.85	.....	.....	130.60	141.00	17.88	21.63
	77.60	76.70	74.70	73.90	73.80	74.35	91.35	96.85	96.85	.....	.....	.....	.....
St. Louis	j 112.00	112.00	110.00	108.00	108.00	115.00	115.00	115.00	115.00	115.00	115.00	14 .555	17.555
San Francisco	d 87.50	87.50	88.50	88.50	88.50	88.50	75.00	75.00	75.00	.....	.....	7 .33g	8.83g
Seattle	75.00a	75.00a	75.00a	75.00a	75.00a	75.00a	75.00a	75.00a	75.00a	.....	.....	.....	.....

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Spruce. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *c* 5M ft. or less. *d* Sales through wholesale distribution yard (F.o.b. purchaser's truck or carrier, San Francisco paid). *e* Plus sales tax. *f* Up to 18 ft. *g* Lower rate by water shipment. *h* 50,000 lb. minimum. *i* FBM, scarce, no stable quotation, no ceiling. *j* Delivered in 500 ft. lots. *k* These are retail yard prices. Lumber is no longer available on the base previously quoted. Less 2% for cash.

Note: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on ¼", $95.15: on ¾", $104.85: price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Jan. 16, 1946 Single or Double Thickness A quality	B quality	EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50 lb. cases delivered in 200 lb. lots*	
Atlanta	76%	76%	$0.195	
Baltimore	70–10%	71–10%	.195	
Birmingham	76%	76%	.15	
Boston	77%	78%	.195	
Chicago	68%	68%	.195	
Cincinnati	77–10%	77–10%	.195	Price of 60% Ammonia Gelatin is $0.0125 per lb. higher than 40%
Cleveland	67–10–10%	67–10–10%	.195	
Dallas	76%	76%	.2075	
Denver	68%	68%	.20	
Detroit	77%	77%	.195	
Kansas City	70.10%	70.10%	.195	
Los Angeles	86%*d*	88%*d*	.2025	
Minneapolis	68%	68%	.19	
Montreal	40–5%*ab*	47%*ac*	.2125	
New Orleans	....	....	.205	
New York	73%	74%	.265*f*	
Philadelphia	69%	70%	.195	
Pittsburgh	77%	77%	.1675	
St. Louis	77–10%	77–10%	.20	
San Francisco	66%	73%	.20	
Seattle	59%*g*	60%*g*	.2025	

a Discount from list Sept. 1939: sales tax included, but 6% tax exemption not allowed for. *b* Single thickness. *c* Double thickness. *d* Discount from jobbers' list Sept. 15, 1928. *f* In borough of Kings, Queens and Richmond, and in Manhattan south of Canal St., add delivery charge of $6.00 per trip. *g* Apr. discounts were same as for May.

* Urban prices influenced by service charges or local storage and delivery regulations do not consistently reflect quantity prices in less congested areas.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla. and Me.	$0.15	$0.175	$0.195
W. of Miss. to Rocky Mtn. States, Fla. and Maine	.155 –.1625	.18 –.1925	.20 –.2125
Rocky Mtn. States	.155 –.1675	.18 –.1975	.20 –.2175
Pacific N. W. States	.1525–.165	.1825–.195	.2025–.215
Pacific S. W. States	.15 –.1575	.18 –.1875	.20 –.2075

PILES, TIES F.O.B.

PILES

Prices per linear foot, fir and pine, bark on, f.o.b. cars, New York. Fir based on Wash. and Ore. points to New York shipping area; pine based on freight from Norfolk.

Dimensions	Points	Length	By Rail — Pine *	Fir
12 in. at butt	6 in.	30 to 50 ft.	$0.34	....
12-in.—2 ft. from butt	6-in.	50 to 59-ft.	.35	....
12-in.—2 ft. from butt	6-in.	60 to 69-ft.	.36	....
12-in.—2 ft. from butt	6-in.	90 to 100-ft.	....	.57
13-in.—3-ft. from butt	5-in.	91 to 100-ft.	....	.62
14-in.—2-ft. from butt	6-in.	50 to 69-ft.	.41	.66
14-in.—2-ft. from butt	6-in.	70 to 79-ft.	.43	.60
14-in.—2-ft. from butt	5-in.	80 to 85-ft.	.54	....
14-in.—2-ft. from butt	5-in.	85 to 89-ft.	.57	....
14-in.—2-ft. from butt	5-in.	90 to 100-ft.	....	.67

* Pine piling over 80-ft. available only in limited quantities.

RAILWAY TIES

Prices f.o.b. per tie for carload lots:		6"x8"x8' Untr.	6"x8"x8' Tr.	7"x9"x8'6" Untr.	7"x9"x8'6" Tr.
Boston	Oak	$1.50	.....	$2.00	.....
	Pine	2.00	$3.00*a*	2.50	$3.00*a*
New York	S. L. Sap Pine	1.65	2.85	2.00	3.30
	Mixed Oak	1.80	3.05	2.50	3.60
Birmingham	Hardwood	1.00	1.60*a*	....	2.25*a*
Chicago	Red Oak	.....	2.65/2.75*a*	.....	3.55/3.70
Los Angeles	Douglas Fir	2.10	3.35*a*	3.00	4.80*a*
Philadelphia	Red Oak	.....	2.10*ag*	.....	3.25*ag*
St. Louis	White Oak	1.80	.....	2.50	.....
	Red Oak	....	2.40*a*	....	3.40*a*
	Sap Pine or Cypress	2.20	.....	....	.....
San Francisco	Douglas Fir	1.25*bet*	.....	.....	3.00*eaf*
Montreal	Birch or Maple	.....	1.65	1.04	.....

Tr.—Treated; Untr.—Untreated. *a* Creosoted. *b* 6"x8"x8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* F.o.b. cars. † Out of market. *g* January 1943 price, none later available.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder in drums f.o.b. works, per 100-lb	$2.50– 3.10
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77–80%, flaked, 100-lb. paper bag, del'd, ton	21.50–38.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.55
Soda ash, 58%, in paper bags, per 100 lb. dense	1.28
Sulphate of aluminum, commercial, in 100-lb. bags	1.15–1.20
Sulphate of copper, in bbl., per 100-lb	7.10

BE WISE! *Modernize Now with* LAPLANT-CHOATE RIGS

Hunter Construction Co. of Ada, Oklahoma, is another of the hundreds of smart earthmovers who are finding that modern LaPlant-Choate scrapers move more dirt at less cost—even with old tractors. Note the heaping load being handled by this LaPlant-Choate C-114 on a highway relocation job near Ardmore, Oklahoma.

Why gamble with inefficient pre-war scrapers when you can get modern LPC's in a hurry!

The old story about "trying to do *tomorrow's* jobs with *yesterday's* equipment" is *doubly* true of scrapers—because it's the scraper that handles the payload, which in turn controls your profit on every job. Consequently, in times like these, it just doesn't pay to struggle along with inefficient, old style scrapers that waste valuable pay yardage, burn up tractor power and require excessive maintenance. Far better to replace those old "relics" *now* with modern LaPlant-Choate units—proved by competitive tests to be the *easiest loading, fastest spreading scrapers on the market.* This way you'll get higher average production at lower over-all cost and thanks to LPC's modern open top design, which simplifies loading with shovel or dragline, you'll also be able to use your scrapers for utility hauling and spreading. Best of all, LaPlant-Choate scrapers in most sizes (from 2 to 14 yd. struck measure) are ready for *immediate delivery.* So don't delay. Better get complete facts today from your nearest LPC distributor. LaPlant-Choate Manufacturing Co. Inc., Cedar Rapids, Iowa; 1022 77th Ave., Oakland, California.

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Positive FORCED EJECTION SCRAPERS

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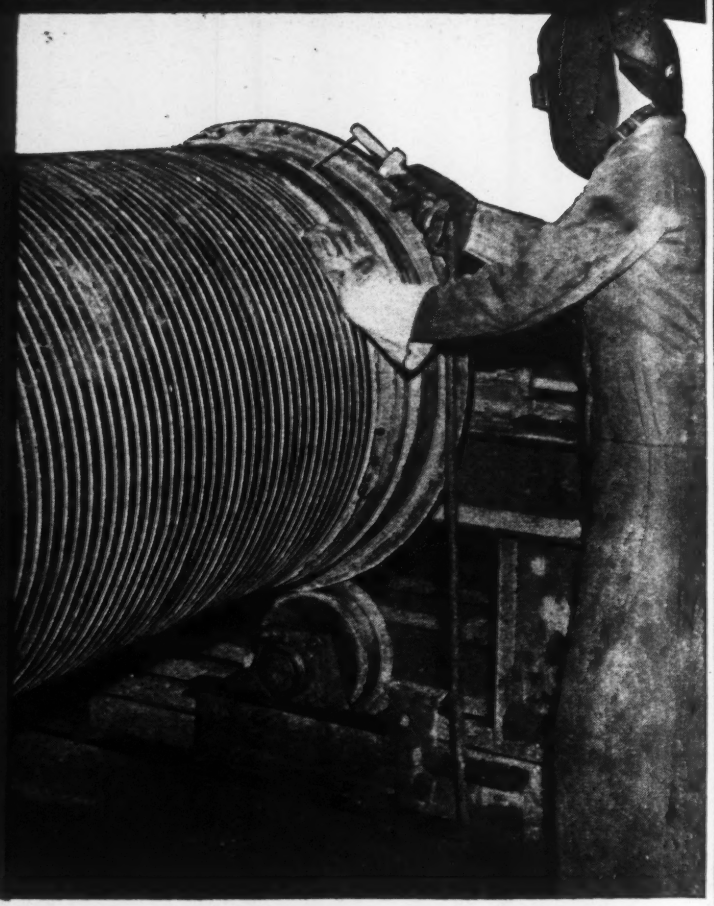
ADVANTAGES OF PRESTRESSED CONCRETE CYLINDER PIPE • NO. 1

Higher Pressure Ranges



• **PRESTRESSING,** already well recognized as the normal trend of development in the design of reinforced concrete structures, is a "natural" for pressure pipes because of their tubular shape.

Lock Joint Pipe Company has applied the principles of prestressing steel in tension and concrete in compression in the design and manufacture of Lock Joint Prestressed Concrete Cylinder Pipe.

Retaining all the inherent advantages of the fundamental principles of Lock Joint pipe design, the use of high tensile steel makes possible still higher pressures in a greater range of sizes in keeping with Lock Joint economy of first cost and maintenance.

When you specify Prestressed Concrete Cylinder Pipe, you can depend upon a pipe of maximum elastic qualities as well as a pipe with the inherent benefits of water-tightness, durability and permanent high carrying capacity of steel cylinder design.

A Hazen-Williams Hydraulic Slide Rule will gladly be sent upon request with our compliments.

LOCK JOINT Reinforced Concrete PRESSURE PIPE

LOCK JOINT PIPE COMPANY

Established 1905

P. O. BOX 269, EAST ORANGE, NEW JERSEY

Denver, Colo. · Chicago, Ill. · Kenilworth, N. J. · Kansas City, Mo. · Rock Island, Ill. Joplin, Mo. · Valley Park, Mo. · Cleveland, Ohio · Hartford, Conn. · Navarre, Ohio

SCOPE OF SERVICES *Lock Joint Pipe Company specializes in the manufacture and installation of Reinforced Concrete Pressure Pipe for Water Supply and Distribution Mains of large diameter as well as Concrete Pipe of all types for Sanitary Sewers, Storm Drains, Culverts and Subaqueous lines.*

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE PARTITION — SCORED Per M lots of 2,000 pieces or over, 3x12x12 in.	4x12x12 in.	8x12x12 in.	STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M lots of 2,000 pieces or over, 8x12x12 in	10x12x12 in.	12x12x12 in.	BRICK Per M. in quantity, Common backing	Straight hard	LIME Per ton, Hydrated finishing	In paper, Common hydrated	Carload lot, Pulverized, or lump
Atlanta	$112.50	$132.60	$234.60	$244.80	$273.40	$306.00	$24.00	$24.00	$19.00	$17.50	$17.50
Baltimore	90.00	95.00	175.00	200.00	260.00	300.00	23.75k	29.75k	20.00	15.00	2.50m
Birmingham	97.50	104.00	195.00c	231.00	.....	.....	19.00	21.50	20.11	17.50‡	.....
Boston	105.00†	112.00†	210.10†	252.09†	.....	.....	20.00i	20.00i	21.00†	.....	16.00
Chicago	92.10	98.40	185.20	x	x	x	18.50	19.50	24.00	18.00	.....
Cincinnati	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cleveland	99.50	106.00	195.50	x	x	x	24.00	24.00	19.65	17.15	22.15
Dallas	.....	83.00	.....	.....	.....	.....	18.00	20.00	28.00	22.00	15.00
Denver	105.25	119.00	198.25	230.00	263.50	315.35	26.50	.....	34.80bb	28.00bb	34.00bb
Detroit	106.80	125.10	219.30	252.90	320.20	366.30	24.50f	26.50f	24.00	22.00	22.00
Kansas City	.....	.....	.....	.....	.....	.....	17.50	18.50	34.00	30.00	30.00
Los Angeles	r	r	r	r	r	r	18.00	20.50	21.80	18.80	22.80
Minneapolis	136.50cc	151.50cc	270.40cc	151.50wcc	.....	.....	21.00v	.....g	30.00bb	23.00bb	30.00bb
Montreal	92.50a	98.50a	196.25a	151.50a	.....	294.40a	22.10	31.80	12.50u	14.00u	8.00u
New Orleans	.....	.....	.....	.....	.....	.....	22.50	.....	21.20	18.00	14.10
New York	103.90	110.80	152.35c	166.70hn	x	x	25.50	.....	30.00	24.00	.....
Philadelphia	112.10	119.60	224.20	269.10	321.20	405.10	24.75	27.75	25.65	19.10	19.00
Pittsburgh	98.50	105.80	181.85	217.30	265.85	303.10	24.00	26.00y	19.40cc	16.90cc	2.85m
St. Louis	.....	.....	.....	.....	.....	.....	26.00s	25.00s	.65aa	.50aa	.75s
San Francisco	116.00	130.50	174.00	130.50t	.....	.....	25.00	.....	22.10	22.10	2.21m
Seattle	137.00	147.00	x	147.00ccw	.....	.....	28.50k	33.50k	27.95s	27.95s	3.28m

† F.o.b. a Smooth. b Carload lots delivered to job. c 6 x 12 x 12 in.-3 cell f Includes $3.50 per M. for truck delivery. g No quotation. h F.o.b Perth Amboy, N. J. i F.o.b. Warehouse only. k $1.00 discount. m Per bbl, 180 lb. n 7¼ x 7¼ x 12. Speed tile. o Per bbl., 200 lb. r Not used because of earthquake danger. s 2% discount for cash. t 5¼ x 8 x 11¼. u 8% sales tax included v sand lime. w 5 x 8 x 12. x Not available. y Stacked. z Pebble lime price per 80 lb. sack. aa Price per sack. Lime recently not sold per ton bb LCL, delivered. cc Truck delivery.

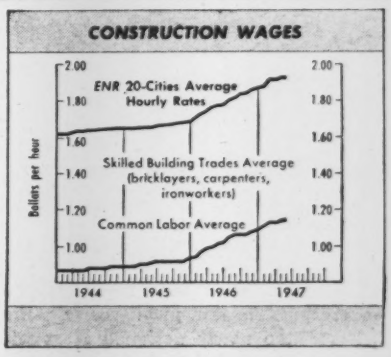
PAINT, ROOFING—F.O.B. CARLOAD LOTS

	RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl. Dry a	WHITE LEAD Per 100 lb. in 100 lb. cases In oil w	READY-MIXED PAINT Graphite b	Per gal., drums Aluminum c	Ferric Oxide d	ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85-90 lb. per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 360 lb. bbl. per ton
Atlanta	$18.75	$27.375	$1.75	$2.70	$1.65	$2.06	$2.06	$2.06	$1.00	$36.00
Baltimore	18.50	27.00	2.25	3.50	2.75	2.35	2.90	2.90	.40	29.00
Birmingham	18.75	27.375	3.36	4.70	....	2.50	2.50	2.50	.33	30.50
Boston	18.50	27.00	1.75	2.50	2.31	2.00‡h	3.30‡ut	3.30‡ut	.25‡	21.00‡
Chicago	18.50	27.00	....	....	....	1.75h*	2.55h‡	2.55h‡	...	29.00‡
Cincinnati	18.50	27.00	....	....	....	.....	.....	.....	...	.....
Cleveland	18.50	27.00	3.00	3.00	3.00	2.21	2.26o	2.26o	.30y	33.00
Dallas	18.50	27.00	....	4.05	....	2.75h	2.90h	3.15h	.80	49.00
Denver	18.50	27.50	2.75	4.35	2.50	2.625	2.625h	2.625h	.365	32.40
Detroit	18.50	27.00	1.75	3.00	1.60	2.25	2.25	2.25	.50	23.00
Kansas City	18.50	27.125	3.30g	3.55g	3.16g	3.00	3.25	3.25	.67	.....
Los Angeles	18.75	27.50	2.80	4.00	3.50	2.60	1.90	....	.60	.....
Minneapolis	18.50	23.88	....	....	....	2.10i	2.15hi	2.15hi	.37	26.00
Montreal	.....	.....	2.90p	4.20p	3.62p	2.85	2.58t	2.07t	.68	1.85k
New York	18.50	27.00	3.45	....	3.45	2.10	2.15o	2.15o	.30z	26.00
Philadelphia	18.50	27.00	1.75/2.00	2.40	1.70	2.54	2.94	2.94	.37	26.00
Pittsburgh	18.50	27.00	1.98	2.40	1.75	2.32	2.37h	2.37h	.37	28.00
St. Louis	18.50	27.00	2.28s	2.89s	1.96s	....	....	....	....	.....
San Francisco	18.75	27.25	1.80	2.75n	1.35	1.96x	....	....	.52	21.115
Seattle	18.75	27.50	3.15	3.15	....	2.75	2.80h	....	.41	35.00j

‡ Delivered. Note: Red lead in oil 50c higher than white lead in oil. a Red lead prices change frequently due to pig lead price changes. b U. S. War Dept. Spec. 3-49A. c ASTM Spec. D266-31. d 80% minimum ferric oxide. f Distributors' price to contractors. g 55 gal. can. h Per roll, 65 lb. i Minneapolis and vicinity. j Asphalt pitch. k per cwt. n May, 1941 price. o 60-lb. roll. p Plus 8% sales tax. s December, 1942 price. t Federal tax included. u 90-lb. roll. v Truck delivery. w Price to large paint contractors is $1.25 less. x Mineral surfaced. y 55-gallon container. z Drums.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$2.00	$1.50	$1.75	$1.75	$2.00	$0.75	$0.85
Baltimore	2.25b	1.775	2.00	1.625/2.00	1.725	1.10	1.10
Birmingham	1.9375	1.50	1.75	1.50/1.75	1.875	.75	.85
Boston	1.995	1.75	1.85	1.80	2.00	1.25	1.25
Chicago	2.00	1.95	2.00	1.95	2.00	1.30	1.30
Cincinnati	.....	....	.....	.....	.....	.....	.....
Cleveland	2.125	2.00	2.125	1.55/2.125	2.125	1.275	1.375
Dallas	2.00	1.625	1.75	1.75	1.875	.90	.90/1.25
Denver	1.98b	1.70	1.70b	1.70b	1.90	1.10	1.35
Detroit	2.00	1.825	2.00	1.85/2.00	2.00	1.275	1.275
Kansas City	2.00	1.75	1.875	1.875	2.00	1.175	.90
Los Angeles	2.00	1.75	2.00	1.75	2.05	1.25	1.25
Minneapolis	1.825	1.65	1.75	1.70	1.90	1.15	1.15
New Orleans	1.9375	1.50	1.875	1.75	1.875	.80	.80
New York	2.50b	2.50b	2.50	2.50b	2.50b	1.50	1.50
Philadelphia	2.00/2.25	1.775	1.90/2.00	2.25	2.00/2.25	1.025	1.025
Pittsburgh	2.15	2.00	2.00	2.05	2.00	1.15	1.15
St. Louis	2.25	1.95	2.00	2.20	2.25	1.20	1.20
San Francisco	2.25	1.75	2.00	1.85	2.25	1.25	1.25
Seattle	2.105	1.805	1.93	1.95	2.105	1.405	1.30
Montreal*	1.17	1.06	1.11	1.00	1.17	.73	.73



b 7 hr. day. * Cost of living bonus now included in basic wage.

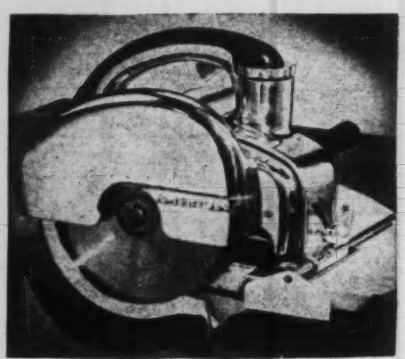
ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) $1.935.

ENR Common Average: $1.146.

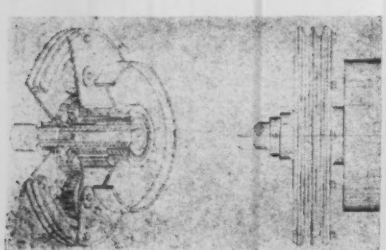
New Aids to the Constructor

MANUFACTURERS' LATEST DEVELOPMENTS IN EQUIPMENT AND MATERIALS

POWER BURNER—Engine and compressor unit is made by Schramm to work in conjunction with latest tank and burner equipment of Aeroil Products Co. Result is packaged machine, without gears, belts or chains, self starting, and with high portable flame production. Two burners make it possible to work in vertical as well as horizontal position without affecting volume or density of flame.—*Aeroil Products Co., 5701 Park Ave., West New York, N. J.*

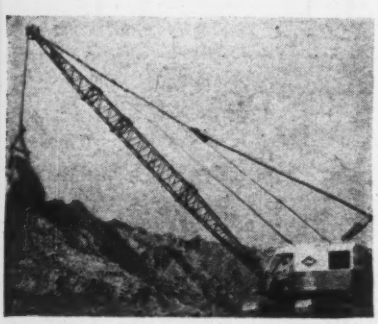


PORTABLE ELECTRIC SAW — Streamlined and highly polished, new saw is said to deliver more power than other saws of its size, due to special General Electric motor developing 1½ hp. with direct power gear drive to 8-in. blade. Free running speed of 6,500 rpm., backed by ample power, maintains cutting efficiency in all types of operation conditions. Blade will make 2⅞-in. straight cut and will saw 2-in. plank with 45 deg. angle cut.—*American Floor Surfacing Machine Co., Toledo, Ohio.*

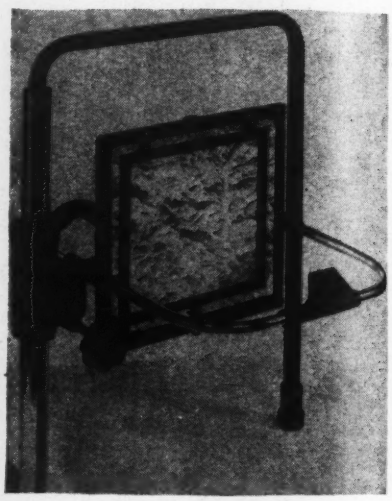


REDUCTION PULLEY — Compactly operating on the inside of a V-belt sheave, the newly designed Hart wide range speed reducer replaces customary gear boxes, gear head motors, and all other types of speed reducers. The pulley's mechanism is entirely enclosed within its own V-belt sheave. Various speed reduction ratios up to 600 to one can be built into the unit.—*Hart Engineering & Sales Co., 2015 W. Claybourn St., Milwaukee, 3, Wis.*

LADDER BASE—Shur-Foot automatic leveler and locking base for ladders consists of aluminum truss that automatically levels ladder laterally on half-circle of strong steel pipe. Abrasive shoes, on ball and socket joints, assure firm grip on any surface. Base requires no adjustment by workman but instantly and automatically adjusts itself to ground level and surface under either foot, levels ladder and is automatically locked in place by weight of ladder. When ladder weight is lifted in moving, Shur-Foot is automatically unlocked for leveling at new location. Base is available for immediate shipment and is furnished in four sizes—to accommodate ladder widths from 16 to 24 in.—*Akron Steel and Sales, Inc., Akron, Ohio.*



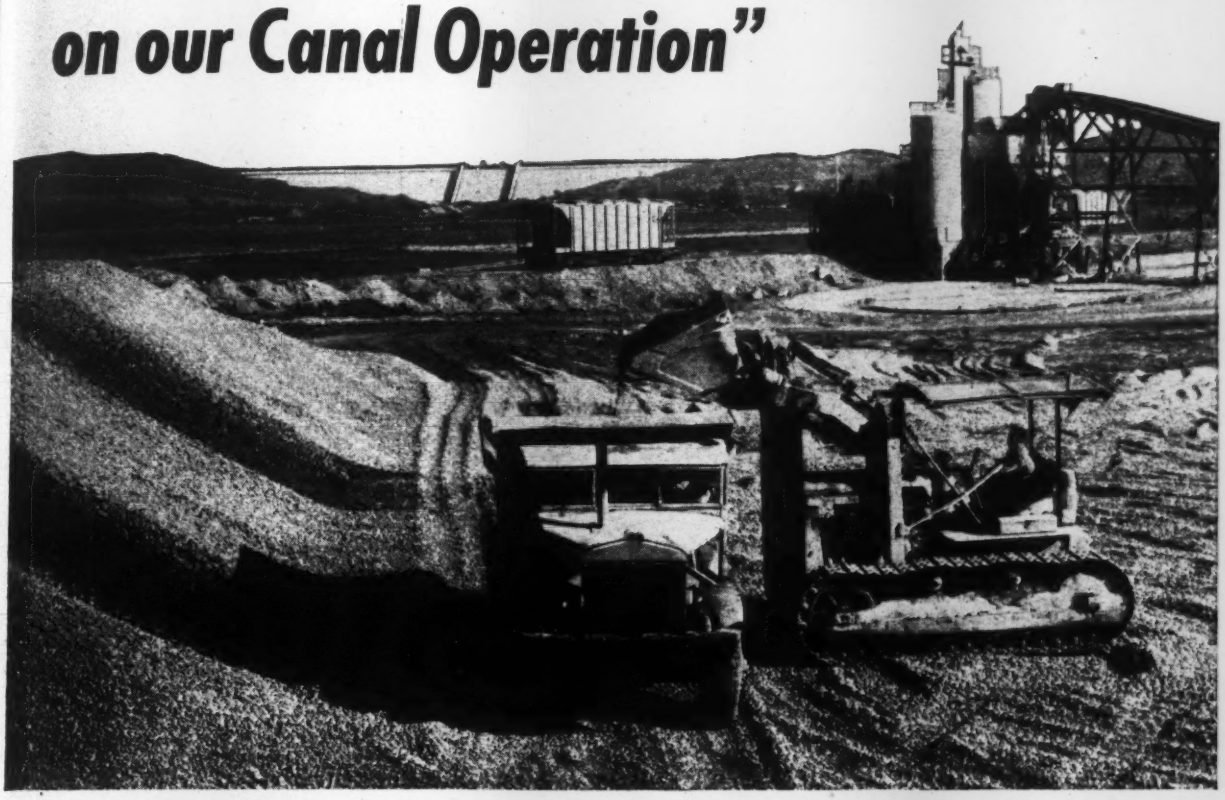
SHOVEL-CRANE-DRAGLINE — New 1½-cu. yd. shovel, crane and dragline has boom of box-type, electrically welded steel construction with wide flaring base. Dipper handle is single unit with one-piece racking. Dipper Type 604 is equipped with independent chain crowd. When machine is working as crane it has capacity of 30 tons at 12-ft. radius. Steering is accomplished with rotating unit in any position through precision air controlled clutches. Rotating frame is of welded steel construction.—*Shovel and Crane Division, Lima Locomotive Works, Inc., Lima, Ohio.*



MAPPING INSTRUMENTS — Rectoplanigraph provides map-maker with simple means of rectifying and transferring planimetric detail from aerial photographs to maps and charts. It is portable, lightweight instrument, easily assembled and disassembled, which can be set on drafting table. Its design provides indexed adjustments for three focal lengths (6, 8¼ and 12 in.), micrometer adjustment for all variations in scale, and other adjustments for rectification of photographs to compensate for errors introduced by tip and tilt. Picture-holder is fitted with masks to accommodate air-photos ranging from 4x5 in. to 9x9 in. High quality prism, used instead of half-silvered mirrors found in other equipment, assures sharp, well-illuminated image. — *Fairchild Camera and Instrument Corp., Jamaica, N. Y.*

COMPACT BOILER—The Pacific steel boiler is a compact unit that is readily disassembled into base, firebox and shell, all of which can enter a building in sections and can be reassembled on the job without welding. The reassembled boiler maintains shop and boiler insurance inspection standards.

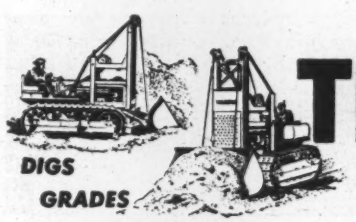
"This TRAXCAVATOR is the Key Machine on our Canal Operation"



IN the shadow of Friant Dam, Peter Kiewit Sons Company has set up an 80-cubic-yard-per-hour concrete batching plant for lining their section of the huge Friant-Kern canal. Their T-7 TRAXCAVATOR loads all of the aggregate used—four sizes of rock, gravel and sand—into 10-yard trucks. Keith Wasson, superintendent says, "This TRAXCAVATOR is the *key machine* on our canal operation." The T-7 was also used for preliminary excavating work on the canal and for many necessary clean-up jobs.

TRAXCAVATORS are built in four sizes — for every job and purpose — with bucket capacities from ½ to 4 cubic yards. Powered by "Caterpillar" track-type tractors, these multi-purpose machines do more work on more jobs with more real savings in time and money than any other single machine you could own. TRAXCAVATORS are virtually one-machine gangs on most every kind of earth-moving and material-handling operation.

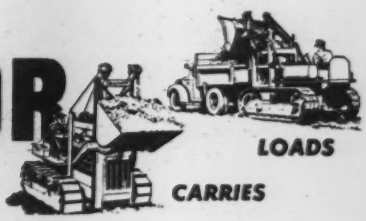
Your TRACKSON-"Caterpillar" dealer will gladly show you why TRAXCAVATORS "ring the bell" with profit-minded, production-geared construction men. See him today, or write direct to TRACKSON COMPANY, Department EN-57, Milwaukee 1, Wisconsin.



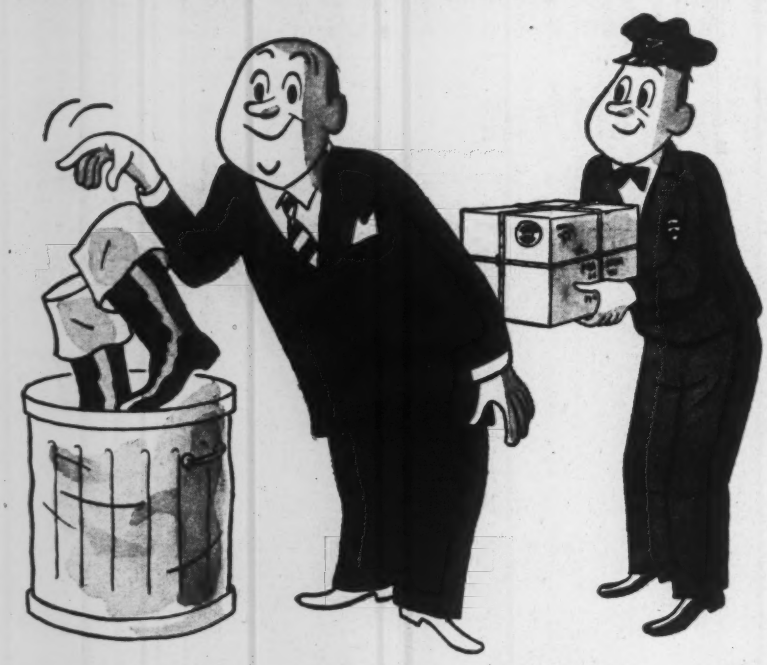
TRAXCAVATOR

REG. U. S. PAT. OFF.

THE ORIGINAL TRACTOR EXCAVATOR



Seven league boots are out of date!



The fastest way *these* days to get supplies and parts for clamoring customers is by super-speedy Air Express. It's like having all your suppliers "right next door" when you specify Air Express delivery. No source — including many abroad — is more than mere hours away.

Planes carrying your Air Express shipments are bigger and faster today, and schedules are more frequent. Air speeds up to five miles a minute make coast-to-coast overnight delivery routine. Air Express rates are low. So keep customers satisfied, and do more business, too. Profit from the speed of Air Express.

Specify Air Express - it's Good Business

- Low rates. • Special pick-up and delivery at no extra cost.
- Direct by air to and from principal U. S. towns and cities.
- Air-rail between 22,000 off-airline offices.
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Just phone your local Air Express Division, Railway Express Agency, for fast shipping action . . . Write today for Schedule of Domestic and International Rates. Address Air Express, 230 Park Avenue, New York 17. Or ask for it at any Airline or Railway Express Office. Air Express Division, Railway Express Agency, representing the Airlines of the United States.

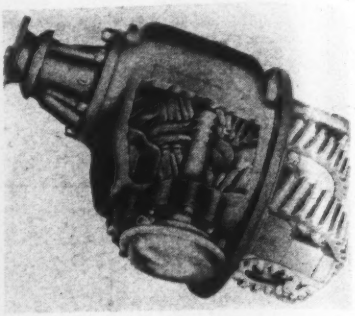
AIR EXPRESS

AIR EXPRESS — GETS THERE FIRST

Rates are low

To Air Express a 16-lb. shipment 1349 miles costs only **$6.39!** Heavier weights — any distance — similarly inexpensive. Investigate!

Elimination of further welding makes a second inspection unnecessary.—*Pacific Steel Boiler Division, United States Radiator Corp., Detroit, Mich.*



REAR AXLES—New line of Timken 3-for-1 rear axles in complete range of sizes for truck capacities extending from GVW rating of 14,500 lb. to GCW rating of 58,000 lb., with each size axle available with three types of final drives, is announced. There are seven basic axles in the new line, E, H, L, Q, R, S and U series. E Series through R Series offers choice of three types of final drives, including hypoid single reduction, hypoid-helical double-reduction and two-speed hypoid-helical double-reduction.—*Timken-Detroit Axle Co.,* 100-400 *Clark Ave., Detroit* 32, *Mich.*

LUMBER SALVAGE TOOL—Named Bord-Pri, this new tool is used in reclamation of old lumber in razing jobs and, in tests, has proved successful in split-free removal of sheathing, siding, flooring and other lumber, so that it remains usable for other installations. Tool lifts flooring, siding, roofing and other wood with such care that no cracks, splits or breaks occur to lower its value. It can lift adjoining pieces of tongue-and-groove flooring and shiplapped siding with ease and damage-free care. When butted against boards to be removed, tool hugs adjacent studding and extended lips support it for positive leverage when pressure is applied to handle. Equal distribution of pressure by this leverage action lifts entire end of board, with no splitting or cracking. It is of sturdy construction, with easy-grip, well-balanced handle, tough head casting, strong lockscrew and freely pivoting, flat-surfaced face plates.—*Maco Corp., Huntington, Ind.*

GREATER HORSEPOWER

FASTER WORKING SPEEDS

MANY IMPROVEMENTS

HIGHER EARNING CAPACITY

• The NEW TRACTORS

The D6

65 drawbar horsepower
2600 pounds additional pull in first

The D4

43 drawbar horsepower
1600 pounds additional pull in first

BOTH

36% larger crankshaft journals
30% larger crankpins
Solid aluminum alloy bearings
Chrome-plated top piston rings
Free-flow manifolding, with individual ports for each cylinder
More effective, single-unit air cleaner
Improved fuel-injection pumps and injection valves
Improved lubricating oil cooling radiator
More effective oil-pressure control
Full-machined cylinder liners, with "no-corrosion" seals

• The NEW MOTOR GRADERS

The No. 12

100 brake horsepower

The No. 112

70 brake horsepower

BOTH

Constant-mesh transmission
Helical gears—for less noise and easier shifting
Arched front axle—for more ground clearance
Steering shock absorber and anti-friction bearings
Improved power-control clutch, with anti-coasting brakes
Other engine refinements as in Tractor engines.

A 50% FACTORY ENLARGEMENT

program now under way will speed "Caterpillar" production to meet the huge demand for "Caterpillar" products.

DIESEL

ENGINES • TRACTORS • MOTOR GRADERS
EARTHMOVING EQUIPMENT

Worthington-Ransome Blue Brute Distributors

See ad on page 115 for list of equipment in each line

Worthington-Ransome Distributors

Ala., Birmingham, Construction Equipment Co.
Montgomery, Burford-Toothaker Tractor Co.
Alaska, Anchorage, Airport Mach. & Storage Co.
Ariz., Phoenix, Lee Redman Equipment Co.
Ark., Fort Smith, R. A. Young & Son
Little Rock, R. A. Young & Son
Cal., L. A. Golden State Equip. Co.
San Francisco, Coast Equip. Co.
Colo., Denver, Power Equipment Co.
Conn., Wallingford, Wilhelm-Davis Co., Inc.
Fla., Gainsville, Constr. Equip. & Supply Co., Inc.
Miami, Allied Equip., Inc.
Orlando, Highway Equipment and Supply Co.
Tampa, Epperson & Company
Ga., Atlanta, Tractor & Machinery Company
Ida., Boise, Olson Manufacturing Co.
Ill., Chicago, Chicago Construction Equip. Co.
Ill., Chicago, Thomas Hoist Co.
Iowa, Cedar Rapids, McNall Mach. & Supply Corp.
Ill., Chicago, J. A. Roche
Ky., Harlan, Croushorn Equip. & Supply Co.
Louisville, Williams Tractor Co.
Maine, Portland, Maine Truck-Tractor Co.
Mich., Muskegon, Lakeshore Machy. & Supply Co.
Minn., Minneapolis, Phillippi-Murphy Equip. Co.
Miss., Jackson, Jackson Road Equip. Co.
Mo., Clayton, The Howard Corporation
Mo., Kansas City, Machinery & Supplies Co., Inc.
St. Louis, W. H. Reaves
Montana, Billings, Interstate Truck & Equip. Co.
Helena, Caird Eng. Works
Nevada, Elko, C. W. Paul Hardware and Machy. Co.
N. J., No. Bergen, American Air Comp. Corp.
N. M., Albuquerque, Bud Fisher Co.
Roswell, Smith Machy. Co.
N. Y., Albany, Milton-Hale Machinery Co.
New York, Hodge & Hammond, Inc.
New York, Railroad Materials Corp.
Syracuse, Milton-Hale Mach. Co.
N. C., Raleigh, Smith Equip. Co.
N. D., Fargo, Smith Commercial Body Works, Inc.
Ohio, Cincinnati, Carroll Edwards & Co.
Dayton, Carroll Edwards & Co.
Ohio, Toledo, The Kilcorse Machy. Co.
Okla., Oklahoma City Tatton-Douglass Equip. Co.
Oregon, Portland, Andrews Machinery
Pa., Wilkes-Barre, Ensminger & Co.
Mechanicsburg, American Equip. Corp.
Philadelphia, Metalweld, Inc.
S. C., Columbia, Smith Equipment Co.
Tenn., Knoxville, Dempster Bros., Inc.
Memphis, Independent Tractor Co.
Nashville, Dempster Bros., Inc.
Tex., Amarillo, T. W. Carpenter Equip. Co.
Dallas, Shaw Equip. Co.
San Antonio, Patten Machy. Co.
Tyler, D. M. McClure Equip. Co.
Utah, Salt Lake City, J. K. Wheeler Mach. Co.
Vt., Barre, A. M. Flanders, Inc.
Wash., Spokane, Andrews Equip. Service
Va., Richmond, Highway Machy. and Supply Co.
W. Va., South Charleston, Allied Equip. Co.
Wisc., Milwaukee, Drott Tractor Co., Inc.

Ransome Distributors

D. C., Washington, M. A. Doetsch Mach. Co.
La., New Orleans, Ole K. Olson Co.
Md., Baltimore, Stuart M. Christhilf & Co.
Mich., Detroit, Thomas G. Abrams
N. Y., Buffalo, Murray Equip. Co
N. Y., Rochester, B-G Equip. Co.
Pa., Pittsburgh, Arrow Supply Company
O., Cleveland, H. B. Fuller Equip. Co.

Worthington Distributors

Ind., Indianapolis, Reid-Holcomb Company
La., New Orleans, Wm. F. Surgi Equip. Co.
Md., Baltimore, D. C. Elphinstone, Inc.
Mass., Cambridge, Field Mach. Company
Mich., Detroit, W. H. Anderson Co., Ind.
Flint, Gransden-Hall & Co.
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MEN AND JOBS

Donald I. Graham, Jr., has been appointed safety director of the National Bureau of Standards and chief of the safety section. He was with the safety and security division of the Office of the Chief of Ordnance, War Department, where he has been engaged in safety studies with regard to the handling, storage, and destruction of military explosives.

Mr. Graham is a graduate in civil engineering of Northwestern University. He has worked as safety director and fire protection engineer for a number of major construction projects and for the Western Factory Insurance Association. In 1941 he became director of safety and fire prevention for various military explosives and rocket powder plants of the D. I. duPont de Nemours and Co., including the Kankakee Ordnance Works, which was adjudged the safest military explosives plant in the country. In 1943 he was transferred to the Hanford Engineer Works, Richland, Wash., where he established the safety program for the government's atomic energy project there.

B. G. Seitz has been assigned to the hydraulic equipment design section, U. S. Bureau of Reclamation, Denver, Colo. He formerly was in charge of the hydraulic and hydrologic design section of the U. S. Engineer Office, Syracuse, N. Y.

Gwoh-Liang Lee has been appointed representative in China of the H. K. Ferguson Co. Mr. Lee formerly did engineering work for railroads and harbors for the Chinese government. He did graduate work at the University of Illinois and took a Ph.D. degree at Cornell.

Frank Belick and **Charles Wehner,** engineers, have been appointed to the staff of San Jose, Calif., City Engineer Harold J. Flannery. Belick will work on the public works department's project of separating San Jose storm and sanitary sewers. He formerly was associated with George L. Sullivan, dean of engineering at the University of Santa Clara, who last year completed a Santa Clara County sanitation survey. Wehner will serve as a street inspector.

Norbert J. Schenkel, civil engineer with William P. Schenkel & Sons, Fort Wayne, Ind., contractors, has been named a member of the Board of Zoning Appeals in that city, succeeding Dick F. Waterfield, who resigned after 13 years of service.

Max A. Ross, Columbus, Ohio, an engineer in the Ohio Highway Maintenance Bureau since 1939, has been named assistant chief of the bureau.

William C. Rindsland has resigned as director, Bureau of Veterans Affairs, University of Minnesota, to accept a position with the Minnesota and Ontario Paper Co. in its engineering division at International Falls, Minn.

Ed Silberman, formerly with the Airways Engineering Division of the Civil Aeronautics Authority, is now a research associate at the St. Anthony Falls Hydraulic Laboratory of the University of Minnesota.

W. T. Dorrance, consulting engineer, has retired after 32 years with the New York, New Haven and Hartford Railroad Co.

H. A. Beckwith, an engineer of Eagle Pass, Tex., has been appointed a member of the Texas State Board of Water Engineers by Gov. Beauford Jester. Beckwith succeeds C. F. Clark, chairman of the board, who resigned.

F. Van Clayton has been elected highway commissioner for the 13th district, South Carolina, comprising Pickens and Greenville counties. He is a resident of Pickens, S. C.

Albion Davis has retired as chief hydraulic engineer of the Union Electric Co. of Missouri in St. Louis. Mr. Davis has worked in the field of river hydraulics and power for the last 33 years—having been connected with operation of the Keokuk hydroelectric plant on the Mississippi since 1914, and of both that plant and the Bagnell plant in Missouri since 1931.

John A. Mutchler, veteran Seabee and former officer in charge of construction at the Naval Proving Ground, Dahlgren, Va., has been appointed resident engineer in charge of construction at the Naval Ordnance Laboratory, White Oak, Md., relieving Commander Bradford Clark, USNR,

GET A LOAD OF THIS LOW-COST MIXING!

Speeding to your construction work, the new Ransome Blue Brute Horizontal Truck Mixer has a way of turning out the best in concrete at costs that mean money in the bank for you. Features like these are the secret of its always expert performance:

Exclusive drum design, stronger and lighter, with Ransome's famous mixing action . . . chilled car wheel metal rollers, each on two Timken roller bearings and running on extra-heavy, heat-treated track . . . smooth, positive gear-and-pinion drive . . . improved transmission with single lever control, two speeds forward and reverse, separate engine clutch and multiple disc reversing clutches . . . trouble-free water system with enclosed pump-clutch, leak-proof poppet valves and unbreakable anti-freeze gauge glasses.

Built with capacities of 2, 3, 4½ cu. yds., this new Ransome Truck Mixer is easier to start, to control, to maintain —a sure bet for time-saving, economical concrete production in transit.

Up above, of course, that's another Blue Brute leader — a Ransome "Big" Mixer — top performer at so many central mixing plants and big-time construction jobs . . . and another reason why *there's more worth in Worthington-Ransome.* R7-4

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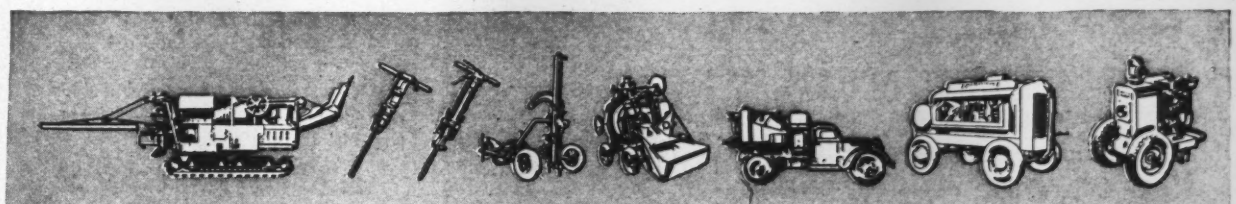

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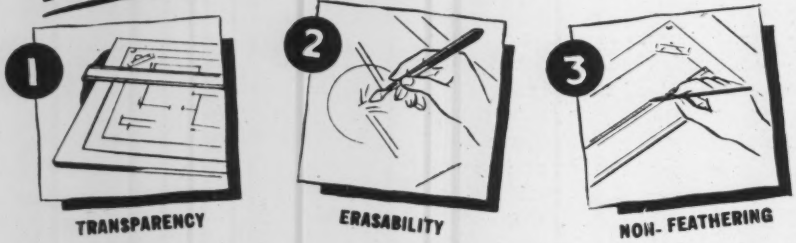

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who has returned to inactive duty. Mr. Mutchler received his degree in civil engineering from Cornell University, 1924. Prior to his entrance into the Naval Reserve as a lieutenant in 1942, he was employed by the New York Central and the Southern Railroads in charge of the construction of bridges, and for eight years was district engineer for the U. S. Public Roads Administration. Mr. Mutchler served with the Seabees as resident officer-in-charge of construction of an air base on one of the Aleutian Islands.

The Compton, Calif., city council has named **City Engineer Roy Robins** as director of public works in charge of a $411,800 water department expansion.

Deane S. Terry, Jr., has been appointed city traffic engineer of Stockton, Calif. He has been traffic coordinator of the San Joaquin Safety Council.

Frank A. Randall has taken into partnership **Frank A. Randall, Jr.**, and **John D. Randall** as Frank A. Randall and Sons, structural engineers, at 205 W. Wacker Drive, Chicago 6, Ill.

R. L. Groover, of Wilmington, N. C., assistant chief engineer of the Atlantic Coast Line Railroad, has been promoted to chief engineer to succeed **L. S. Jeffords,** who has been named general manager. **C. S. Sanderson,** also of Wilmington, who has been serving as principal assistant engineer, has been named assistant chief engineer, and **W. J. Turner,** formerly engineer of maintenance of way for the southern division, also has been named assistant chief engineer. **M. W. Clark,** office engineer at Wilmington, has been named principal assistant engineer, and has been succeeded as office engineer by **C. R. Lapeza,** who has been division engineer at Savannah, Ga. **L. E. Bates,** who has been roadmaster of the Wilmington District, has been named engineer of maintenance of way for the southern division at Jacksonville, Fla.

Groover, the new chief engineer, is a graduate of Alabama Polytechnic Institute. He has been with the railroad since 1914, and during the war served as associate director of ways and structures, Office of Defense Transportation, Washington, D. C.

Robert E. Eddy, Beatrice, Neb., who has been a state highway engineer for the last six years, has resigned.

Raymond D. Leary, a civil engineer graduate of Marquette University and a former resident engineer for the Sewerage Commission of Milwaukee,

Cut construction costs TWO WAYS

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• Experience on all types of jobs all over the country has proved the long-run economy of Amcreco Creosoted Products. Pressure creosoted, they provide long life and dependable service even under the severest conditions. Plan to get the complete facts, today

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HEAVY-DUTY HIGHWAY AND AIRPORT FORMS The 7/32" form is recommended for all concrete slab construction up to 20' widths. The 1/4" form is recommended for slab widths over 20' widths.

HELTZEL LIP CURB FORMS Quickly and easily affixed to the road form by means of two swivel clamps.

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HELTZEL INTEGRAL CURB FORMS A positive rigid form assembly for building curbs integrally with the road slab.

HEAVY-DUTY ROUND STAKE PULLERS Pay for themselves on any job by providing a method for quickly and easily withdrawing stakes.

HELTZEL STEEL CURB-and-GUTTER FORMS Sections are 10' long and two supports are furnished for each section.

RIGID RADIUS OR FLEXIBLE STEEL FORMS Available to match any specification.

HELTZEL HEAVY-DUTY DOWEL JOINT CURB FORMS These forms furnished in any height and to match any cross section.

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FINISHING TOOLS FOR CONCRETE ROADS

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Wis., has been appointed a member of that commission.

Guy B. Smith has resigned as city engineer of Little Rock, Ark., on account of poor health.

Evan P. Phillips has been appointed manager of operations for W. C. Smith, contractor, in the Portland, Ore., area. He previously had been with the Thompson Starrett Co., Brayton Engineering Co., Dinwiddie Construction Co., Lorenz Brothers and the George H. Buckler Co.

W. D. Shannon of Seattle, a national vice-president of the American Society of Civil Engineers, and member of the Washington state House of Representatives was chairman of the public utilities committee and as a member of a sub-committee on appropriations for state institutions, he prepared a schedule of capital construction and obtained an appropriation for state institutions, he prepared a schedule of capital construction and obtained an appropriation of $20,000,000.

Col. Howard M. Smitten, 69, bridge engineer of the Western Pacific Railroad, San Francisco, retired recently after 25 years service. He attended schools in Honolulu and San Francisco, and entered the University of California, but soon joined the San Francisco Bridge Co. He then worked successively for Pacific State Telephone and Telegraph Co., Meyer & O'Brien and the Southern Pacific Co., for which he handled the preliminary design of various major bridge super-structures, notably the Dunbarton draw-bridge. In 1917 he entered the United States Army, Quartermaster Corp, as captain, construction division with the 2nd U. S. Engineers. After the organization of the 34th Engineers, he was promoted to major and attached thereto. While in France, Smitten was promoted to lieutenant colonel and placed in command of the 37th Engineers.

U. S. Geological Survey who have been with that department from 41 to 52 years retired on March 31. They are: **John E. Blackburn,** who served 45 years as topographer with the Survey, first employed on mapping Indian territory and later on war emergency mapping with the Alaskan Branch; **J. Irving Gayetty,** assistant topographic engineer for 45 years, who worked in eighteen eastern states and was assigned to the section of inspection and editing; and **Lee Morrison,** topographer for 41 years and who joined the survey in 1903 to work mostly in the western states on mapping mountainous coun-

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A Baker's rigid, sturdy construction gives you the heft that is necessary for tremendous down pressure, and terrific pushing power — its simplicity means less linkage, fewer points of wear, less down time—and new machine rigidity throughout the life of the unit.

When there's yardage to move and the going is rough — call on a tractor-bulldozer team that has the speed, hitting power and balance you need to lick it — see your nearby A-C Baker distributor today.

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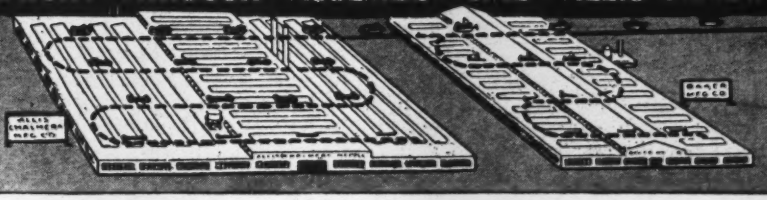

The modern Baker plant with its completely equipped fabricating, machining and blacksmithing shops adjoins the Allis-Chalmers crawler tractor plant. When you order an A-C tractor with Baker bulldozer or grodebuilder, your tractor leaves the A-C assembly line, crosses a narrow court and goes on the Baker final assembly line.

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CONTROLLED AIR WITH AEA

To date, DAREX AEA has been used in approximately 15,000,000 cubic yards of concrete—in highway and pavement construction, in mass concrete, and in structural concrete.† In all of these projects control of entrained air was of utmost importance. Despite a wide range of mixes, aggregates, and field conditions, the required percentage of entrained air was obtained by simple adjustment in the amount of DAREX AEA used.

†DAREX AEA is also extensively used in concrete products.

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DISPENSERS FOR AEA

Hand operated, semi-automatic, and fully automatic DAREX dispensers are now available for adding DAREX AEA to the concrete batch. These dispensers are inexpensive, accurate, sturdy, and very flexible in their adaptability to existing plants. We offer a choice of models for ready mixed concrete plants, paving mixers, and concrete plants as set up for dams and large concrete structures. For further information, write Dewey and Almy.

Try DAREX AEA on your next job

In air entrained concrete it's the controlled air that counts.

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DIAMOND AND SHOT CORE BORINGS — DRY SAMPLE BORINGS

Foundation Testing for Bridges, Dams and All Heavy Structures

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try. In 1914 Morrison transferred to the Coast and Geodetic Survey to work along the Canadian border for the International Boundary Commission and retired in February 1939 but was reappointed in 1942 when the survey needed topographers for war mapping. **William H. Morey,** a topographer with 49 years of service with the Survey, has also retired. He began making topographic surveys in 1898, and in 1920 was appointed custodian of field equipment. Since 1928 he has been computing transit traverses. **Rufus H. Sargent,** a topographic engineer for 52 years, is the fifth man now retiring. He began his work for the Survey in South Dakota and Alaska. He became topographic engineer for the Alaskan Branch until his appointment to chief, section of inspection and editing in 1937. His work has taken him to China, Mexico, Argentina and Bolivia.

Edward McC. Beardslee, who since 1942 has been engaged in city manager work in Florida, has returned to private engineering, becoming office engineer with Shutze and Armistead, successors to the firm of Hentz, Adler and Shutze, of Atlanta, Ga. He was project engineer on the Camp Stewart and Camp Gordon projects for J. B. McCrary Engineering Corp. of Atlanta, in 1940 and 1941.

R. O. Green operating superintendent and assistant chief engineer for the Central Nebraska Public Power & Irrigation District, at Holdrege, Neb., has joined the reclamation bureau and will work in the Republican River division.

The W. J. Parker Construction Co. of Omaha, Neb., has opened offices at Pierre, S.D., with **L. D. Howard,** who recently resigned as maintenance engineer for the South Dakota highway department, as manager of the Dakota division. The company will specialize in sewer and water systems, water filtration, sewage treatment plants and storm sewer construction.

E J. Stuber has been appointed contracting engineer of the fabricated steel construction division of the Bethlehem Pacific Coast Steel Corp. During the war, Stuber served in the Navy in the inspection of materials section and later worked on contract terminations. He received his civil engineering degree from Rensselaer Polytechnic Institute in 1940.

Charles Capper, Northwood, Iowa, has been appointed county engineer of Wayne County, Iowa, headquarters at Corydon. He succeeds Floyd K. Brown. Mr. Capper was formerly Worth County Engineer at Northwood.

There's One Best Engine for every application — the Continental Red Seal Engine Expressly designed for the job

At any given horsepower in Continental's broad range, there are up to 20 engines from which to choose. This enables you to specify the engine with exactly the characteristics demanded by the job it has to do.

The Continental Red Seal line includes both overhead and L-head engines, available for operation on gasoline, butane, fuel oil, natural gas or distillate. There are also five heavy-duty Diesels of advanced design. In this complete Continental line of specialized engines, there is one best model for your needs . . . one engine truly ***built for the job.***

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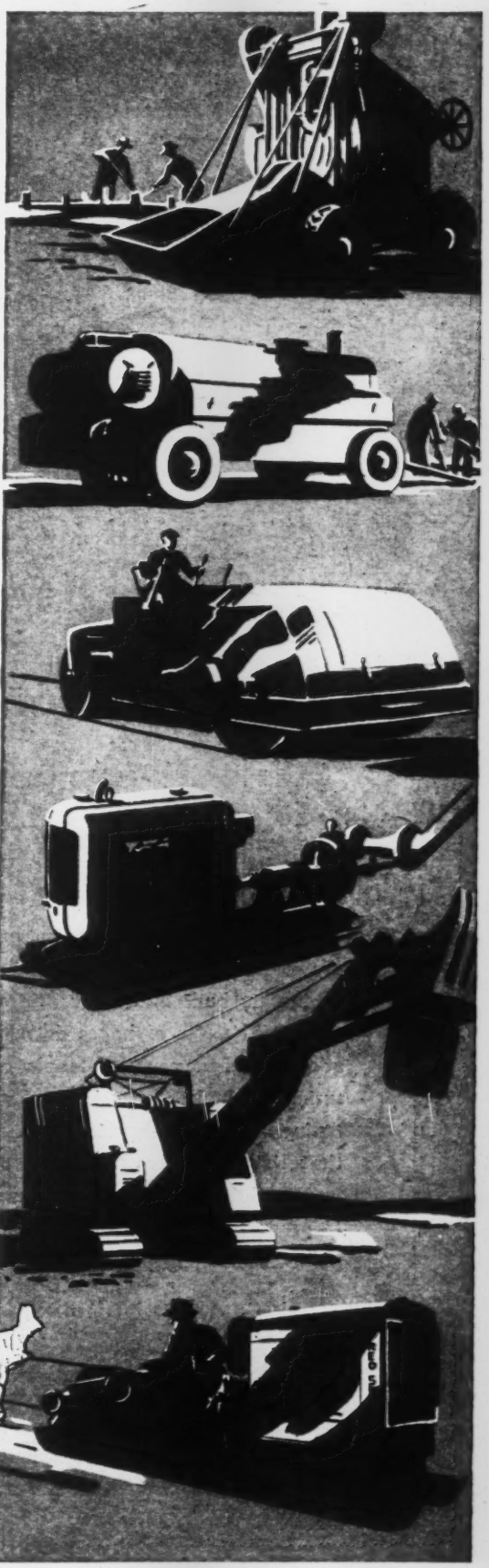

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The experience of an organization which has produced more than 2¼ million air-cooled engines is built into every Briggs & Stratton engine. Theories or hopes do not dictate the adoption of designs, materials or manufacturing methods — *actual experience and long testing do. . . .* The experience of users proves that Briggs & Stratton engines stand up under all kinds of service — year after year — proof that they are *designed right — built right — the right power for your equipment.*

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FOR INDUSTRIAL CONSTRUCTION RAILROAD AND FARM EQUIPMENT

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Elections and Activities

Paul R. Speer, St. Paul, Minn., water resources engineer, United States Geological Survey, has been elected president of the Minnesota Federation of Engineering Societies.

Other officers are Garrold Feeland, Minneapolis, first vice-president; Hugo Schlenk, Jr., Clognet, second vice-president; E. G. Ward, Willmar, third vice-president; and John L. Wilson, St. Paul, secretary-treasurer.

The federation now consists of 14 engineering societies and is in a flourishing condition.

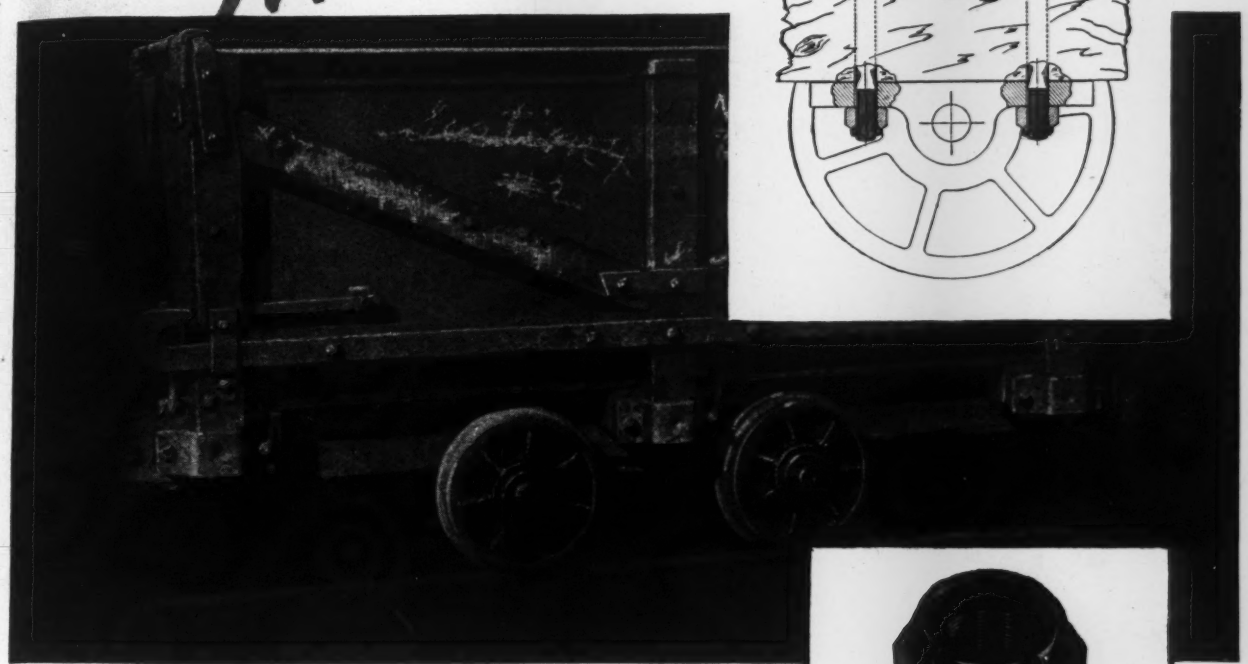
Federal control of stream pollution will require the erection of a vast, new and expensive bureau, and will not be able to deal effectively with local contamination problems. These were the conclusions drawn by Louis Auerbacher, Jr., Counsel, Passaic Valley Sewerage Commission, Newark, N. J., speaking before the recent 32nd annual meeting of the New Jersey Works Association.

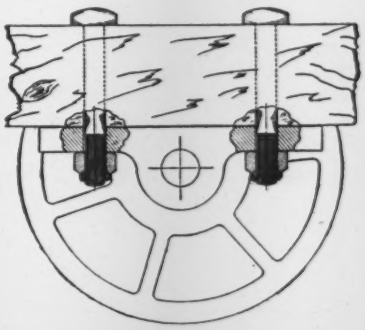
Furthermore, Mr. Auerbacher said that the proponents of national control were using the fallacious argument that little had been done to accomplish pollution abatement during the last seven years. He pointed out, while this statement was true, the local agencies had been restricted by the war. Considerable progress is, however, now being made under the interstate compacts and the joint efforts of the states, municipalities and industries.

Francis S. Friel, president of the Federation of Sewage Works Associations awarded the Harrison P. Eddy medal to Dr. H. Heukelekian, research engineer, Agricultural Experiment Station, New Brunswick, N. J., for his paper, "The Relation Between Accumulation, Brochemical and Biological Characteristics of Film, and Purification Capacity of a Bio-filter and a Standard Filter."

George B. Cherry, state superintendent of building and grounds, was elected president of the Raleigh, N. C., Engineers Club recently. E. F.

SELF-LOCKING *Reduces Maintenance* ON THE WHEEL PEDESTAL BOLTS





— the Red Elastic Collar protects against costly breakdowns caused by VIBRATION!

Detachable fasteners on the wheel pedestal bolts of wooden frame mine cars have two difficult jobs. First, they must hold tight against the violent vibration built up by heavy, hard riding on poor tracks, uneven road-beds and flat wheels. Second, they must maintain their positioned settings on the bolts as the unstable timbers seat and unseat them during the alternating operating cycles of wetness, dryness and freezing.

Fastener failure means derailment, tied-up equipment and disrupted production.

Here again, actual mine tests have proven that ESNA Elastic Stop Nuts—with the self-locking, self-sealing and reusable Red Elastic Collar—hold tight permanently!

Easily removed and reusable ESNA Elastic Stop Nuts provide dependable protection against Vibration, Thread Corrosion, Thread Failure, and Liquid Seepage. Industrial distributors are stocked and ready to serve you. And ESNA engineers are available to study your fastener problems. Address: Elastic Stop Nut Corporation of America, Union, New Jersey. Sales Engineers and Distributors are conveniently located in many principal cities.

LOOK FOR THE RED COLLAR
THE SYMBOL OF SECURITY

It is threadless and dependably elastic. Every bolt—*regardless of commercial tolerances*—impresses (does not cut) its full thread contact in the Red Elastic Collar to fully grip the bolt threads. In addition, this threading action properly seats the metal threads—and eliminates all axial play between the bolt and nut.

All ESNA Elastic Stop Nuts—*regardless of size or type*—lock in position anywhere on a bolt or stud. Vibration, impact or stress reversal cannot disturb prestressed or positioned settings.

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ELASTIC STOP NUTS

INTERNAL WRENCHING

ANCHOR

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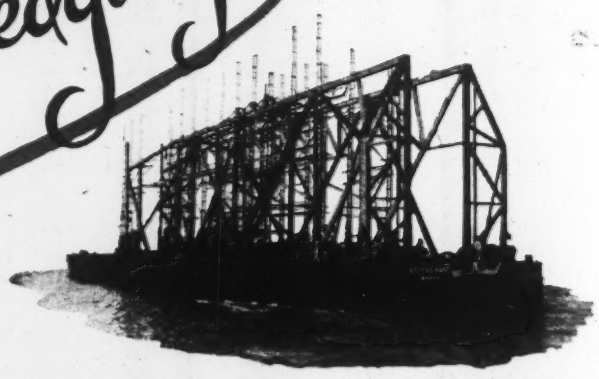
Something NEW in Placer Dredging



WITH a displacement of over 4000 tons and hull length of 246 feet, the "Stuyvesant," one of two identical units now being built by Bucyrus-Erie for tin mining service off the Netherlands East Indies isle of Banka, is the largest placer dredge ever to be built in the United States.

But it is the "Stuyvesant's" design, not its size, which is of most significance to placer mining. Typical of its "years ahead" engineering is the widespread use of Ward-Leonard variable-voltage control, permitting variations of speed and power in digging and maneuvering to suit the variable operating conditions always encountered. Use of this control eliminates many factors which limit output in fixed-speed operation by putting power to work in the amount and kind required. With power so metered, the "Stuyvesant's" 216-foot digging ladder with its string of 148 14-cubic foot buckets, with both deck- and ladder-mounted idlers, can supply the 128-cell all-jig washing plant at the varying optimum rate for highest overall efficiency.

This application of Ward-Leonard control to placer dredging concretely illustrates Bucyrus-Erie's ability to draw on both specialized experience and a wide general background in designing and building placer dredging equipment. In taking your dredging problems to Bucyrus-Erie, you look to the only dredge manufacturer who has the advantage of experience gained not only in 66 years of building placer dredges but in the same number of years devoted to producing almost every type of excavating and earthmoving equipment for both dryland and underwater operation.

12D47C

BUCYRUS ERIE

SOUTH MILWAUKEE, WISCONSIN

Hoefer, of the engineering faculty at N. C. State College, was elected vice-president, and Frank H. Brant of the State Highway and Public Works Commission was re-elected secretary-treasurer.

James D. Mooney, president and chairman of the board of Willys-Overland Motors, Inc., Toledo, has been elected president of the Ohio Good Roads Federation. Hal G. Sours, of the Baldwin-Sours Co., Columbus, and former state highway director, was elected first vice-president. W. Robert Timken, vice-president of Timken Roller Bearing Co., Canton, second vice-president; and Guy C. Baker, vice-president and general manager of American Aggregates Corp., Greenville, O., third vice-president. Floyd W. Mohler is executive secretary.

Prof. G. Perry Steen of the civil engineering department of the University of New Mexico was elected president of the newly formed New Mexico Society of Professional Engineers at a meeting held in Albuquerque, March 21-22. Other officers included: C. M. Johnstone, district engineer for the state highway department at Santa Fe, vice-president; Steven Reynolds of Albuquerque, vice-president; and W. K. Wagner of Albuquerque, secretary-treasurer. The new organization supplants the former New Mexico Society of Engineers and will be affiliated with the National Society of Professional Engineers.

Officers of the Connecticut Society of Civil Engineers are as follows: President, F. Walden Wright, Hamden; first vice-president, Albert A. Cross, West Hartford; second vice-president, William A. D. Wurts, Hartford; director ex-officio, Henry W. Buck, Wethersfield; director district 1, H. Irving Skilton, Hartford; director district 1, William S. Wise, West Hartford; director district 2, Kenneth H. Holmes, New London; district 3, William M. Bolton, New Haven; director district 3, Russell G. Warner, New Haven; director district 4, Melville F. Taylor, Stamford; director district 5, Henry C. Whitlock, Waterbury; secretary and treasurer, H. Jackson Tippet, Box 235, New Haven, assistant secretary, Kenneth E. Foote, New Haven; and assistant secretary, Joseph D. Drury, New Haven.

George B. Langord, of the University of Toronto, has been elected president of the Association of Professional Engineers of Ontario, succeeding G. Ross Lord. Walter A. MacKay, registrar and secretary-treasurer for the last ten years, has resigned. At the anniversary dinner of the association the first award of an annual medal of the association was made to C. D. Howe, Dominion Minister of Reconstruction and Supply, in recognition of his war services as Canada's Minister of Munitions and Supply.

Prof. S. B. Earle of Clemson College was named chairman of a committee including M. H. Wood, county engineer, and R. K. Rouse, to organize a South Carolina State chapter of the National Society of Professional Engineers.

H. Bradley has been elected president of the British Columbia Contractors' Association at Victoria, B. C. A. H. Winters, is vice-president, and P. M. Townsend secretary-treasurer. The executive board elected at the recent annual meeting is composed of D. Donaldson, E. Cross, W. J. Drysdale, A. Whiteman, W. Bartlett and A. E. Evans.

Joe Fry, Little Rock, has been elected president of Arkansas chapter, Association of General Contractors of America. He succeeds Ben M. Hogan of Little Rock. D. F. Jones was elected first vice-president, G. W. May second vice-president, and Ray Metzger was re-elected secretary-treasurer. Directors are Richard Linebarger, L. K. Scharff and B. B. Hill, Jr.

Harold W. Smith, of Dinwiddie Construction Co., has been elected president of the Central California Chapter of Associated General Contractors. Carl N. Swenson, San Jose, was chosen vice-president and Robert McCarthy, treasurer. William E. Hague was continued as secretary-manager.

Nearly 200 members and guests of Section 9, New York State Association of Highway Engineers, attended the organization's recent 17th annual dinner at Binghamton, N. Y. Speakers included State Public Works Superintendent Charles H. Sells; Albany; Deputy Chief Engineer Guy Pinck, Albany; and Binghamton District Engineer Frank W. Donovan. Honored by the association were Daniel J. Edgerton and Al Goodenough, retired state workers of the Binghamton District Office.

Anthony Wayne chapter, Fort Wayne, Ind., of the Indiana Society of Professional Engineers has elected Richard J. Erb president; Charles Lichtenberg, vice-president; Ralph Walb, secretary; John Moriarty, treasurer; and James T. White, director.

For unselfish service and accomplishment as a scientist, engineer and educator in promoting the happiness, comfort and well-being of humanity, Karl T. Compton, president, Massachusetts Institute of Technology, on Feb. 26 received the Washington Award for 1947 of the Western Society of Engineers. The award was made by Titus G. Le Clair, president of the society, at a dinner attended by more than 600 in the Hotel Continental, Chicago. A commission comprising representatives of the sponsor society and the four founder engineering societies elected the recipient. The award was founded in 1916 by the late John Watson Alvord, prominent sanitary engineer.

University of Akron chapter of the American Society of Civil Engineers has elected Joseph Koegel president; William Ruhlin, vice-president; Charles Cockerham, secretary; and Samuel Green, treasurer.

W. J. Moore, member of the Ontario Municipal Board and former engineer of Renfrew County, has been elected president of the Ontario Good Roads Association. D. J. Emrey (County Engineer of Waterloo County) was elected first vice-president, and Victor H. Evans second vice-president. At a recent meeting a resolution endorsed a province-wide highway safety campaign which has been launched by the Ontario Minister of Highways. Another called for the setting up of a committee on highway research to be sponsored by the association and affiliated with the Ontario Research Commission.

Charles F. Grisham, New London, Conn., has been appointed executive vice-president of the Connecticut Chapter of the Associated General Contractors of America by Burton V. Bartlett, Hartford, president of the Connecticut Association. Captain Grisham, retired from the U. S. Navy, January 1 after 40 years service.

Paul M. Johnson, Helena, Mont., has been elected president of the Montana section of the American Society of Civil Engineers. He succeeded C. S. Heidel, also of Helena. Other officers elected were Fred E. Thieme, Missoula, first vice-president; Wilbur S. Hanna, Billings, second vice-president, and E. H. Thomas, Helena, secretary.

N. P. Hayes of Greensboro, vice-president of the Carolina Steel and Iron Co., has been elected president of the North Carolina section of the American Society of Civil Engineers. Other officers elected are: E. D. Burchard of Raleigh, junior vice-president; R. E. Stiemke of North Carolina State college, senior vice-president, and George H. Maurice of Eagle Springs, secretary-treasurer.

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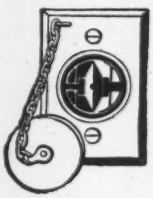
Are you familiar with the great variety of products in General Electric's full line of wiring devices? Do you know the interesting features that help to make them easy to use and safe to specify? Keep an eye on this column, and you may discover a lot of useful facts and information. We'll keep dishing them out for you.

When you're planning for farm buildings, summer camps, warehouses, garages and other light construction, remember that General Electric makes a full line of surface wiring devices that is easy to install and that provides long service. The line includes switches, convenience outlets, lampholders, and junction boxes. All are strongly made, light in weight, and resistant to moisture and corrosion. Use them for BX* or Braid-X* cable installations, or for knob and tube wiring. All General Electric surface wiring devices are fully approved by the Underwriters' Laboratories, Inc. Ask us for a descriptive folder.



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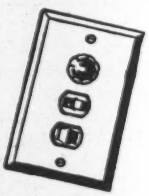

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Reports and Pamphlets

(*Continued from p. 96*)

THE USE OF HEAVY EQUIPMENT FOR OBTAINING MAXIMUM COMPACTION OF SOILS—VIBRATORY AND IMPACT COMPACTION OF SOILS—Bulletin No. 109. American Road Builders' Assoc.

THE COLORADO RIVER—U. S. Department of the Interior, Bureau of Reclamation. Obtainable from the Superintendent of Documents, Washington, D. C.

CONTRACT CLOSES FOR COST-CONSCIOUS EMPLOYERS—Labor Relations Institute, 1776 Broadway, New York 19, N. Y. $2.25.

THE INTEGRATION OF WATER USE IN NEBRASKA — By G. E. Condra. Bulletin No. 29. The University of Nebraska, Conservation & Survey Division, Lincoln, Nebr.

HANDBOOK OF TESTING SOILS—By J. M. Turnbull. State Rivers & Water Supply Commission, Victoria, Australia.

PARKING—By W. S. Smith & C. S. LeCraw. The Eno Foundation for Highway Traffic Control, Inc., Saugatuck, Conn.

REPORT TO THE LEGISLATURE OF THE STATE OF NEW YORK—By the Joint Legislative Committee Studying the Problem of Checking Erosion Along the Atlantic and North Shores of Long Island. Albany, N. Y.

COVERED BRIDGES—By Edward Hungerford. American Branch, The Newcomer Society, New York.

OHIO STREAM FLOW—Part II—Bulletin No. 127—By C. V. Youngquist. Engineering Experiment Station, Ohio State University, Columbus 10, Ohio. $1.

LEARNING TO WELD—The Lincoln Electric Co., Cleveland 1, Ohio. 25c.

URBAN FREEWAYS—By the Committee on Urban Transportation, American Institute of Planners. American Transit Assoc., 292 Madison Ave., New York, N. Y.

CALIFORNIA REPORTS ON PLANNING—State Reconstruction & Reemployment Commission Sacramento, Calif.

ORIGIN-DESTINATION TRAFFIC SURVEY—Milwaukee Metropolitan Area—State Highway Commission of Wisconsin, Milwaukee, Wis.

LIGHTWEIGHT AGGREGATES FOR CONCRETE—Office of the Housing Expeditor, Washington 25, D. C.

SUBDIVISION CONTROL—State of New York, Department of Commerce, Albany, N. Y.

ENGINEERING EDUCATION—ITS NEW RESPONSIBILITIES—Rensselaer Polytechnic Inst., Troy, N. Y.

FORECASTING A CITY'S FUTURE—Pamphlet No. 12—California State Reconstruction and Reemployment Commission, Sacramento, Calif.

SCIENCE AT NEW ALTITUDES—By David Sarnoff. From address at Cincinnati Technical & Scientific Societies Council, Cincinnati, Ohio.

MODERN TIMBER CONSTRUCTION IN EUROPE—Engineering Extension Series Bulletin No. 45—By E. G. Stern. Virginia Polytechnic Institute, Blacksburg, Va.

BITUMINOUS COATINGS FOR THE PROTECTION OF IRON & STEEL AGAINST CORROSION—Report No. 5—By R. St. J. Preston. Chemical Research Laboratory, Teddington, Middlesex, England. Price 1s.

SURFACE WATER SUPPLY OF VIRGINIA—Bulletin No. 4 Potomac, Rappahannock and York River Basins. Bulletin No. 5 James River Basin. Bulletin No. 6 Chowan and Roanoke River Basins. Bulletin No. 7 New, Big Sandy & Tennessee River Basins. Virginia Conservation Commission, Division of Water Resources & Power Charlottesville, Va.

OPERATION OF THE ILLINIOS STATE GEOLOGICAL SURVEY—By M. M. Leighton. State Geological Survey, Urban, Illinois.

PARKING—By W. S. Smith & C. S. LeCraw. The Eno Foundation for Highway Traffic Control, Saugatuck, Conn.

PROTECTIVE ORGANIC COATINGS AS ENGINEERING MATERIALS—By J. Mattiello. American Society for Testing Material, 1916 Race St., Philadelphia 3, Pa. $1.50.

PUBLIC CONTROL OF HIGHWAY ACCESS AND ROADSIDE DEVELOPMENT—By David R. Levin. For Sale by the Superintendent of Documents, Washington 25, D. C. 35c.

TEMPERATURES OF NATURAL WATERS IN PENNSYLVANIA—Prepared in cooperation with U. S. Department of Interior Geological Survey. Department of Forests and Waters, Harrisburg, Pa.

HOUSING IN CANADA—Central Mortgage & Housing Corp., Economic Research Division, Ottawa, Canada.

RELATION OF THE ENGINEERING PROFESSION TO INDUSTRY—By C. B. Jolliffe. Dept. of Information, Radio Corp. of America, 30 Rockefeller Plaza, New York 20.

TRAFFIC SAFETY EDUCATION—Eno Foundation for Highway Traffic Control, Saugatuck, Conn.

WEATHERING TESTS ON ASBESTOS-CEMENT ROOFING MATERIALS—By F. E. Jones. Department of Scientific & Industrial Research, 24 Rutland Gate, London. Price 1s.

ENGINEERING EDUCATION IN LATIN AMERICA—By S. S. Steinberg. Reprinted from the Journal of Engineering Education, University of Pittsburgh, Pittsburgh, Pa.

THE SCALING OF CONCRETE PAVEMENTS—By R. T. Devereaux. USE OF AIR-ENTRAINING CONCRETE IN PAVEMENT CONSTRUCTION—By C. A. Walls. Special Report No. 1., American Public Works Assoc., 1313 East 60th Ct., Chicago 37, Ill. Price 50c.

A SUGGESTED PROGRAM FOR THE REDEVELOPMENT OF THE WEIRS, N. H.—State Planning & Development Commission, Concord, N. H.

THE INDUSTRIAL UTILITY OF THE SURFACE WATERS OF OHIO—Prepared in cooperation with the Water Resources Branch, U. S. Geological Survey. Ohio Water Resources Board, Columbus, Ohio.

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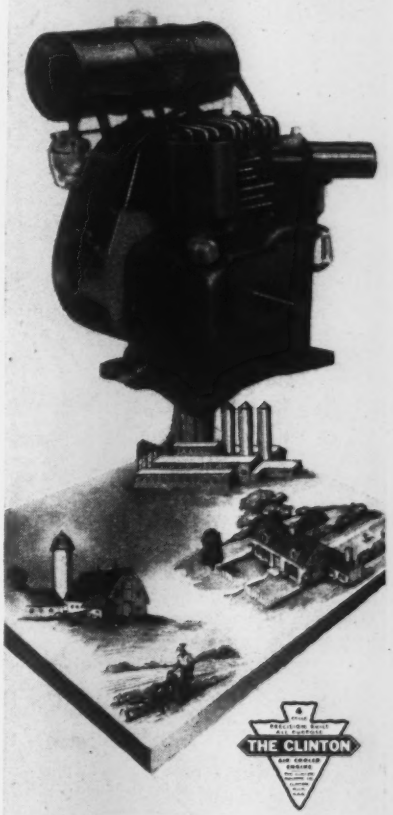

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Manufacturers' Activities

Promotions of two officials of the CUMMINS ENGINE COMPANY, INC., Columbus, Ind., pioneer builder of high speed diesel engines, have been announced. V. E. McMullen is now executive vice president and R. E. Huthsteiner is vice president and general manager. The management simultaneously announced the appointments of Leonard W. Beck as general sales manager and Waldo M, Harrison as controller.

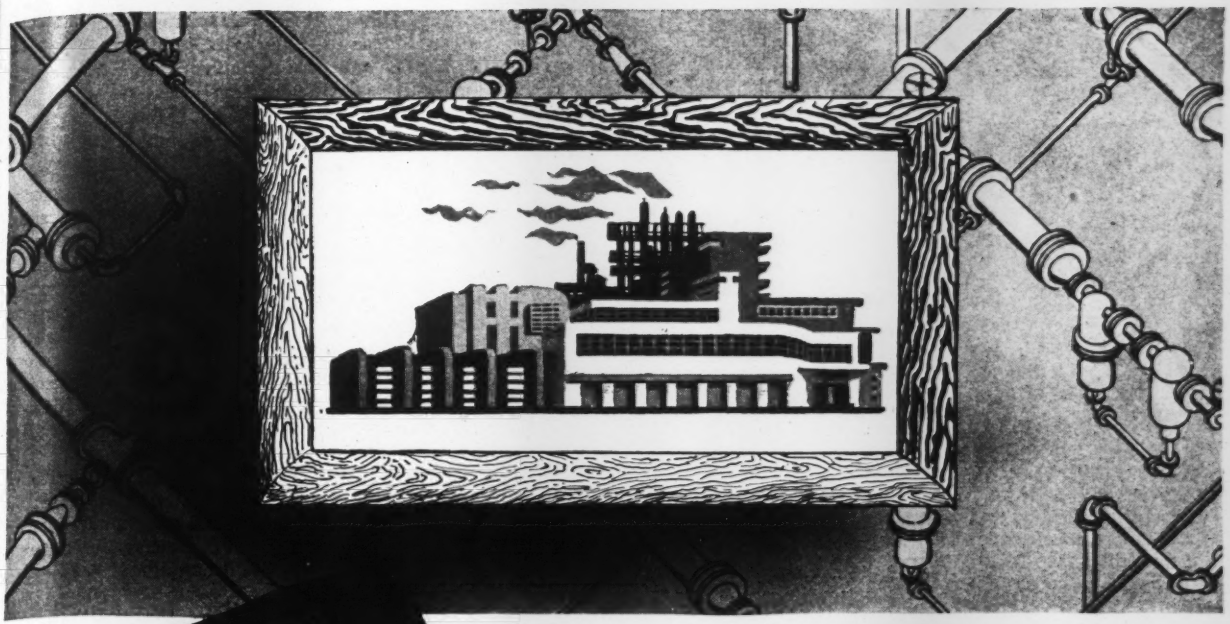
PRESTON M. HALL, an outstanding figure in the resistance welding industry, has accepted the position of technical executive of the Resistance Welder Manufacturers' Association.

KAISER CO., INC., iron and steel division, Oakland, Calif., announces the appointments of C. F. Borden as assistant general sales manager and R. L. Asquith as product sales manager, tubular and specialty products. Jack L. Ashby, general sales manager of Kaiser Steel, will continue as Oakland district sales manager in addition to his new responsibilities.

Production from native Minnesota stone of materials urgently needed for the building of homes and for other construction will be greatly increased by THE CARNEY CO., INC., as the result of a $250,000 modernization and expansion program at its quarries and plant at Mankato, Minn. The Carney Co., organized in 1883, manufactures and distributes rockwool insulation, natural cement, masonry cements and lime and crushed stone products throughout western half of the United States.

AT A RECENT board meeting of the Mississippi Valley Structural Steel Co. at Decatur, Ill., the following new officers were named: P. W. Armstrong, vice-president, was assigned new duties and responsibilities in charge of shop operating methods and equipment; E. T. Blix was appointed manager of the Melrose Park Plant, and J. C. Anrtzen was appointed chief engineer of the Melrose Park Plant.

THE UNION WIRE ROPE CORP. has announced expansion of its technical staff, conducting its unique testing and research laboratory. Walter Voightlander, a mechanical engineering grad-



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STOPS MOISTURE FROM FALLING INTO TRACTOR EXHAUST . . Just slip the "RAINCAP" over the open end of your tractor exhaust, and you eliminate forever the danger of moisture falling into the exhaust, injuring your tractor.

- Immediate delivery
- Liberal Dealer Discount.

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3	2 3/8"	1.90
5	1 7/8"	1.90
55	2"	1.90
6	1 1/2"	1.90
7	2 1/2"	1.90
8	3"	2.50
9	3 1/16"	2.50
10	3 1/8"	2.50
11	3 1/4"	2.75
12	4"	3.00

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uate of Stevens Institute of Technology and for the past 40 years actively engaged in technical and research work in the wire rope industry, was named technical director. Charles M. Zerr, also a Stevens graduate, and for the past 12 years an assistant to Mr. Voightlander, was appointed chief engineer of the rope division. Other advancements in the enlargement of the company's technical services include: Raymond O. Kasten, assistant technical director; Robert C. Downey, research chemical engineer; Omer Brenton, assistant metallurgist, and Dwain L. Bedford, metallurgist in charge of the chemical, physical and metallurgical functions of the laboratory.

THE BOARD of directors of the United Engineers and Constructors, Inc., of Philadelphia, Pa., has announced election of Edward L. Keenan as vice president and purchasing agent.

THE MARQUETTE CEMENT MANUFACTURING CO. has announced the appointment of William E. Erwin as its manager of industrial relations, succeeding John J. Kelly, who died Dec. 7 at LaSalle, Ill.

E. J. SCHWANHAUSSER, vice president of Worthington Pump and Machinery Co., was re-elected president of the Diesel Engine Manufacturers Association at that organization's annual meeting held recently in Chicago. Re-elected vice-presidents of the organization were: J. E. Peterson, vice-president of General Machinery Corp.; and Gordon Lefebvre, president of Cooper-Bessemer Corp.

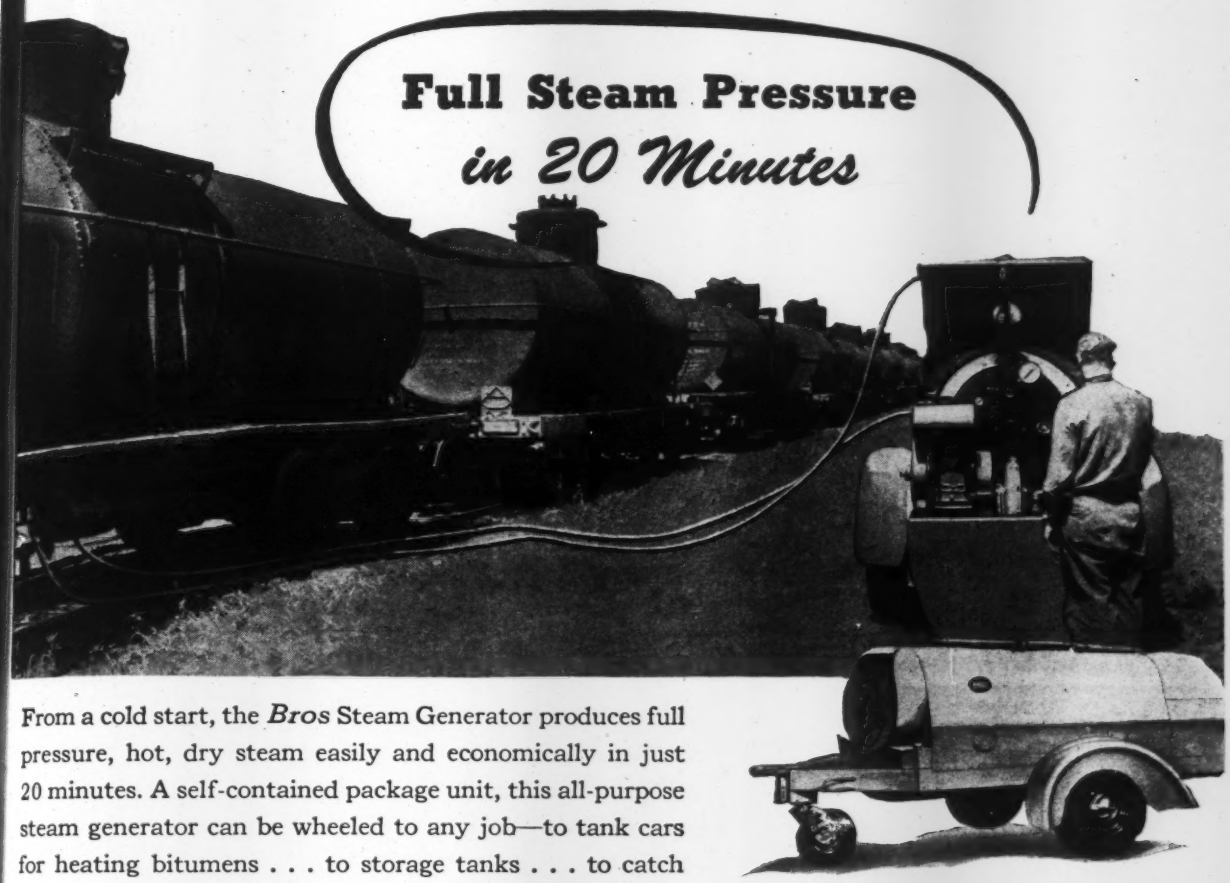
LIMA LOCOMOTIVE WORKS, INC., shovel and crane division, Lima, Ohio, announces the appointment of Interstate Equipment Co., Statesville, N. C. as sales agent for Lima shovels, cranes and draglines in North Carolina.

HENRY P. REID, assistant to president, has been appointed chief engineer of the Universal Atlas Cement Co., United States Steel Corp. subsidiary. He has been associated with the company for 23 years.

ROCHESTER ROPES announces the transfer of eastern sales headquarters, warehouse and export office to its new building at Water, Jefferson and Cherry Streets, New York 2, N. Y.

WESTERN STEEL CO., Corpus Christi, Tex., has been formed to serve as an agency for Truscon Steel Co. (Youngstown) in southern Texas. Firm will engineer, fabricate, and erect structural reinforcing, and miscellaneous steel. C. V. Thornton and W. L. Thornton, Ft. Worth, Tex., are president and secre-

Full Steam Pressure *in 20 Minutes*

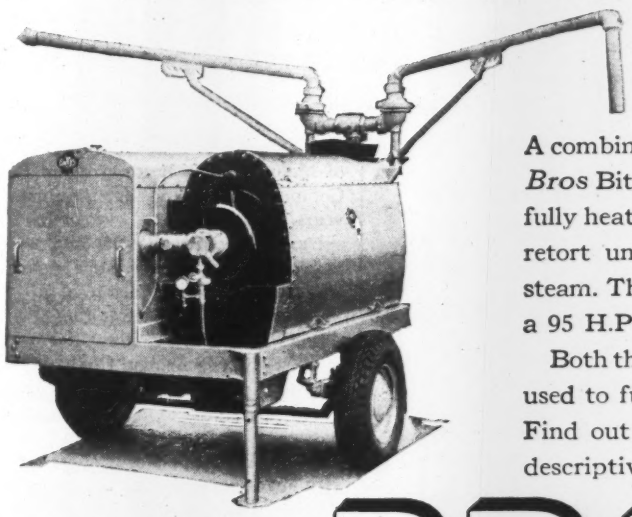


From a cold start, the *Bros* Steam Generator produces full pressure, hot, dry steam easily and economically in just 20 minutes. A self-contained package unit, this all-purpose steam generator can be wheeled to any job—to tank cars for heating bitumens . . . to storage tanks . . . to catch basins for thawing . . . to refrigerator cars . . . to steam pile drivers. As a stationary installation, it serves as operating equipment where steam is needed.

BROS Steam Generator

The attractive, streamlined *Bros* Generator is compact and highly portable. It gets jobs done faster and at lower costs. Available in 26, 41 and 55 developed H.P. units.

Faster Bituminous heating with the BROS CIRCULATOR



A combination heater and high speed pumping unit, the *Bros* Bituminous Circulator needs only 2 to 3 hours to fully heat and unload a 10,000 gallon tank car. Its direct retort unit heats to temperatures unobtainable with steam. The speedy, economical *Bros* Circulator includes a 95 H.P. power unit in its compact design.

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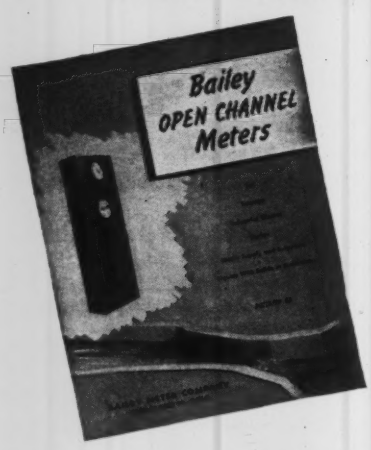

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Murray Hill 3-0554

tary-treasurer, and Harold T. Morton, former assistant chief engineer of Truscon Steel Co. in Youngstown, is vice president and general manager. A new $500,000 industrial plant will be constructed.

E. L. RAHM Co., 720 South Michigan Blvd., Chicago, Ill., announces the opening of a new Chicago plant. This expansion increases the company's production of its Turesco waterproof masonry paint from 2,000 to 40,000 gal. per day, and of Turesco plasticizer from 500 to 2,000 gal. per day. A new product, Ex-Ten, a cream to make oil paint go twice as far, will also be manufactured.

Two new manufacturer's representatives for DRESSER MANUFACTURING DIVISION, Bradford, Pa., have been appointed for the Southeast. Jack P. Orr, Memphis, Tenn., will handle the distribution of Dresser pipe line products in Kentucky, western Tennessee, northern Mississippi, Arkansas and Missouri. Preston S. Avery, Atlanta, Ga., will cover North and South Carolina, Georgia, Florida, Alabama, southern Mississippi and eastern Tennessee.

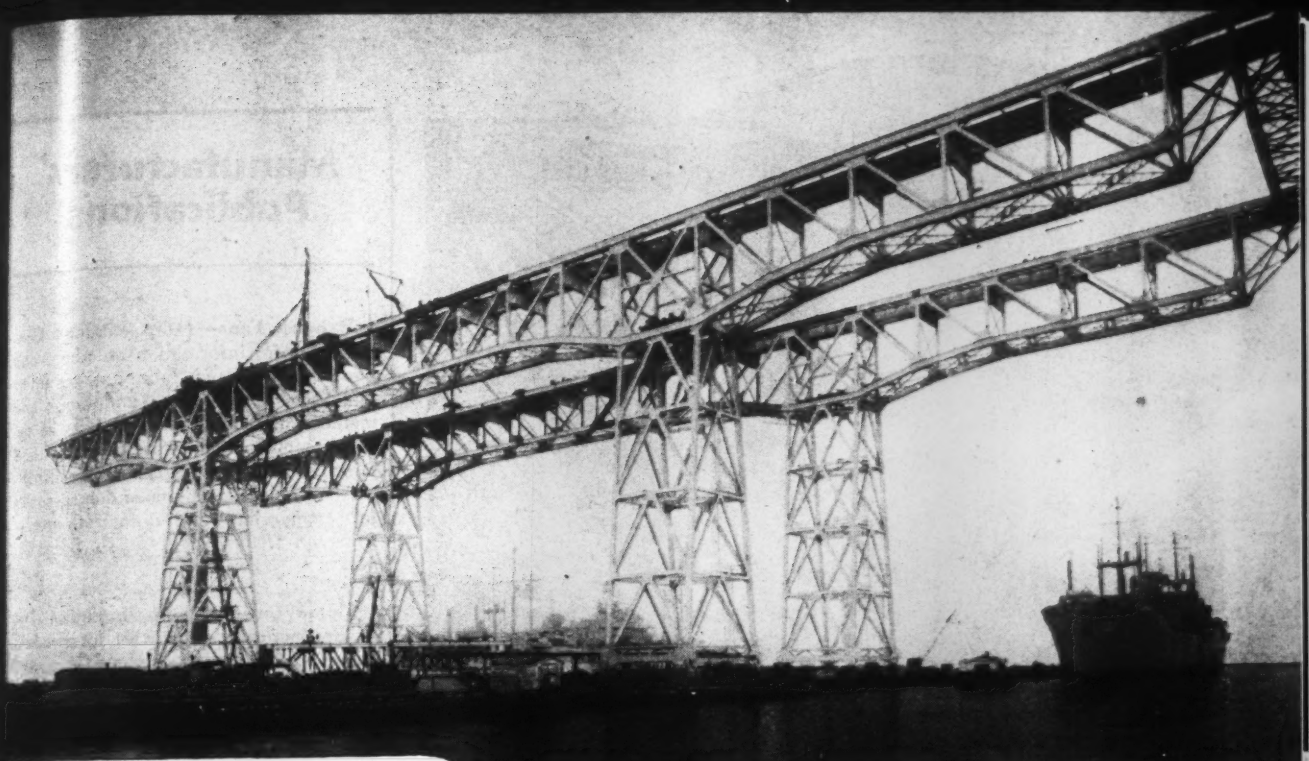
JOHN S. GREGG, manager of Inland Steel Co.'s Cincinnati sales office, has been transferred to the Milwaukee office as assistant district sales manager.

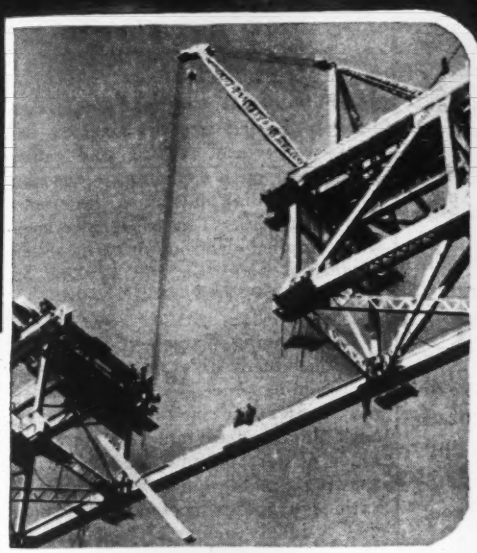
AUSTIN K. THOMAS has been appointed as sales manager of the construction machinery division, Chain Belt Co., Milwaukee, Wis. Mr. Thomas has a background of over 20 years' association with the construction machinery industry.

THE CLAY SEWER PIPE ASSOCIATION, INC., announces the addition to its technical staff of L. O. Keener, effective February 1, 1947. Mr. Keener formerly served as assistant superintendent of highways for Westmoreland County Commissioners, and for a number of years was associated with the Pennsylvania Department of Highways as assistant maintenance supervisor. He will maintain headquarters at 307 Westminster Ave., Greenburg, Pa.

LINK-BELT SPEEDER CORP., Chicago, announces that Hayes Parsons has been made assistant to the president and will have charge of the domestic sales of Link-Belt Speeder "shovel-cranes." His headquarters will be at the Cedar Rapids, Iowa, plant.

H. E. BEANE has been appointed general sales manager of The Bristol Co., Waterbury, Conn. Starting as a sales engineer, Mr. Beane has been associated with the company since 1920.





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THIS CRANE runway for the San Francisco Naval Shipyard at Hunters Point, Calif., is capable of lifting gun turrets and other huge sections weighing as much as a million pounds. American Bridge Company fabricated and erected the structural steel for this massive 8,400-ton structure, including traveling cranes, crane runway bridges, and towers. 730 feet long and extending 162½ feet over the water on each end, the 209-foot high assembly will carry two traveling cranes, each having a 142-foot span, and operating either singly or in tandem.

Inset—American Bridge Erection Crew closing the last runway bridge trusses.

RECORD breaking structures like this new Navy crane runway are rare. But the statement *"Fabricated and erected by American Bridge"* applies equally to thousands of jobs of all types and sizes.

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Manufacturers' Publications

Exhaust Fans—(16-p. catalog) Contains helpful information on where and how to use exhaust fans, how to determine size fan required and types and methods of installation. Details of design, construction, specifications and performance data are given for direct-drive and belt-drive fans and accessories for commercial and industrial use.—*Emerson Electric Mfg. Co., St. Louis 21, Mo.*

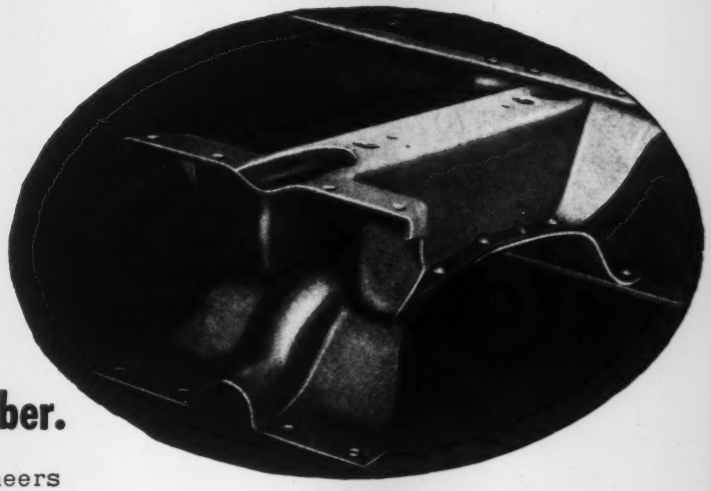
Flame Cutting—(4-p. bulletin) Describes company's facilities for producing plain and intricate shapes from steel plates. Typical flame cut sections are shown, along with information regarding use of irregular shaped steel plates in both production and maintenance work.—*Joseph T. Ryerson & Son, Inc., Box 8000-A, Chicago 80, Ill.*

Welding and Cutting—(64-p. catalog) Is divided into two sections—one for oxyacetylene welding and cutting gases, equipment and supplies, the other for arc welding machines, accessories and electrodes. Ten pages give specially compiled electrode price lists.—*Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y.*

Conditioning Water—(6-p. bulletin) Describes many different types of water conditioning processes and explains applications, advantages and limitations of each. Included are tables listing various kinds of gaseous and solid impurities, showing effects, limits of tolerance for various purposes, methods of removal and residual amount of each impurity after treatment. Comparison chart shows chemical results produced by various water treatment methods. Illustrations show diagrammatically principles of construction and operation of various processes and equipment for softening, clarification and demineralizing of water and other liquids.—*Liquid Conditioning Corp., 423 W. 126th St., New York 27, N. Y.*

Window Equipment—(4-p. bulletin) Describes Dura-seal metal weatherstrip sash balance window equipment.—*Zegers, Inc., 5619 Harper Ave., Chicago 37, Ill.*

Seismograph for Road Sounding—(4-p. folder) Describes light, portable apparatus for use in mineral and oil prospecting, engineering and geological subsurface investigation, solution of



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Consequently, it ties side-members together positively; always keeps them uniformly spaced. It imparts exceptional torsional stiffness to a frame. It won't spraddle. It produces a frame that won't weave, a frame that stays true, a Mack frame!

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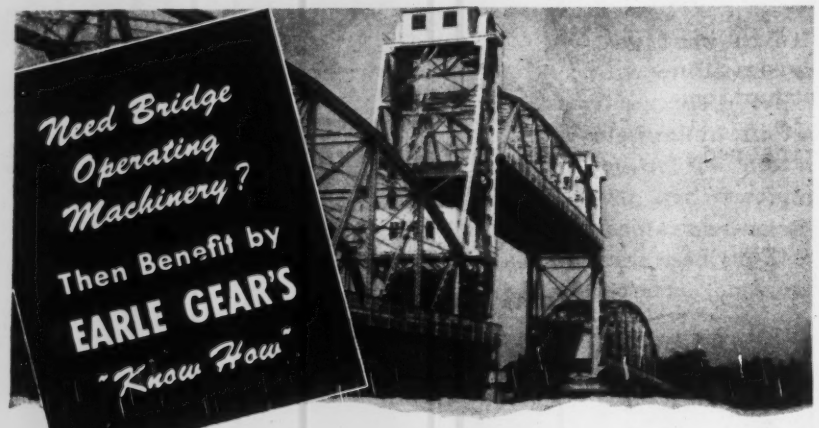

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foundation problems, and study of vibration problems. Specifications are given for oscillograph, camera and detectors. —*Geophysical Instrument Co., Key Blvd and Nash St., Arlington, Va.*

Pipe Fittings—(20-p. catalog) Contains complete application information, structural data, installation procedure, temperature-pressure rating charts, specifications and list prices of fittings for making full pipe strength, permanent, leakproof branch pipe outlets. It also illustrates and describes drain out fittings and complete line of flanges.—*Bonney Forge & Tool Works, Allentown, Pa.*

Recording Speedometer—(12-p. bulletin) Explains in detail operation of Sangamo Tachograph for recording truck operation. It covers such topics as, "Driving By Instruments," "Savings In Maintenance," "Accident Prevention," and "Constant Supervision of Vehicles." — *Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14, Mo.*

Induction Motors — (Die-cut 4-p. folder) Shows cutaway views and details of construction of new E-M heavy-duty squirrel-cage induction motors designed for drip- and splash-proof construction. Available in large-power ratings from 100 to 1,000 hp., 1,800 rpm. and lower.—*Electric Machinery Mfg. Co., Minneapolis 13, Minn.*

Lumber Designs — (1947 edition) Gives typical lumber designs with quantities and materials lists for light and heavy frame structures. Designs employ Teco nector system of construction and are offered as guides in designing for specific jobs—*The Timber Engineering Co., 1319 18th St., N. W., Washington 6, D. C.*

Air Tools for Contractors—(24-p., 2-color bulletin) Shows air tools in action and demonstrates their versatility. —*Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y.*

Jacks—(4-p. folder) Describes in detail various construction uses of Util-A-Tool. It lists wide selection of push-and-pull jacks and steamboat ratchet pulling jacks. Specification charts and price listings are included—*Templeton, Kenly & Co., 1020 S. Central Ave., Chicago 44, Ill.*

Learn Arc Welding—(24-p. pictorial booklet) Explains functions and courses of study pursued at Hobart Trade School. Hobart Arc Welding News with many interesting photographs and articles on welding is also available free of charge. — *Hobart Brothers Co., Troy 1, Ohio.*